# The Journal of ELECTRICITY POWER and GAS

DEVOTED TO THE CONVERSION, TRANSMISSION and DISTRIBUTION OF ENERGY.

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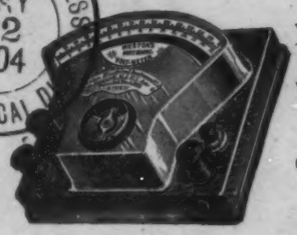

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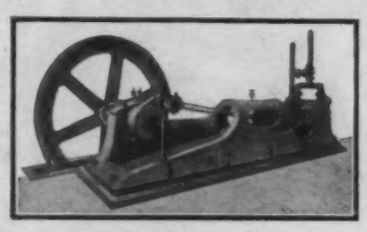

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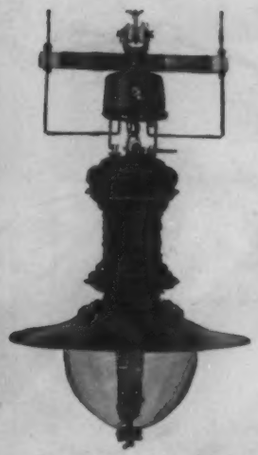

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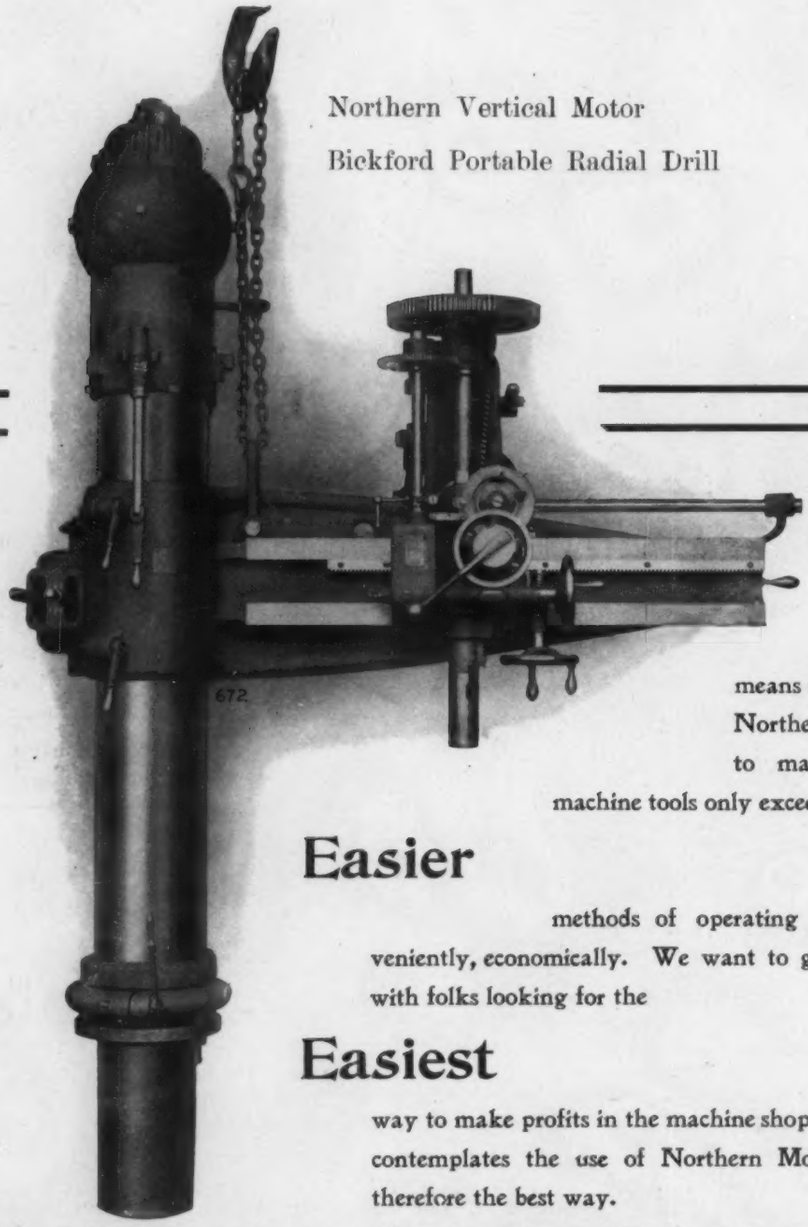

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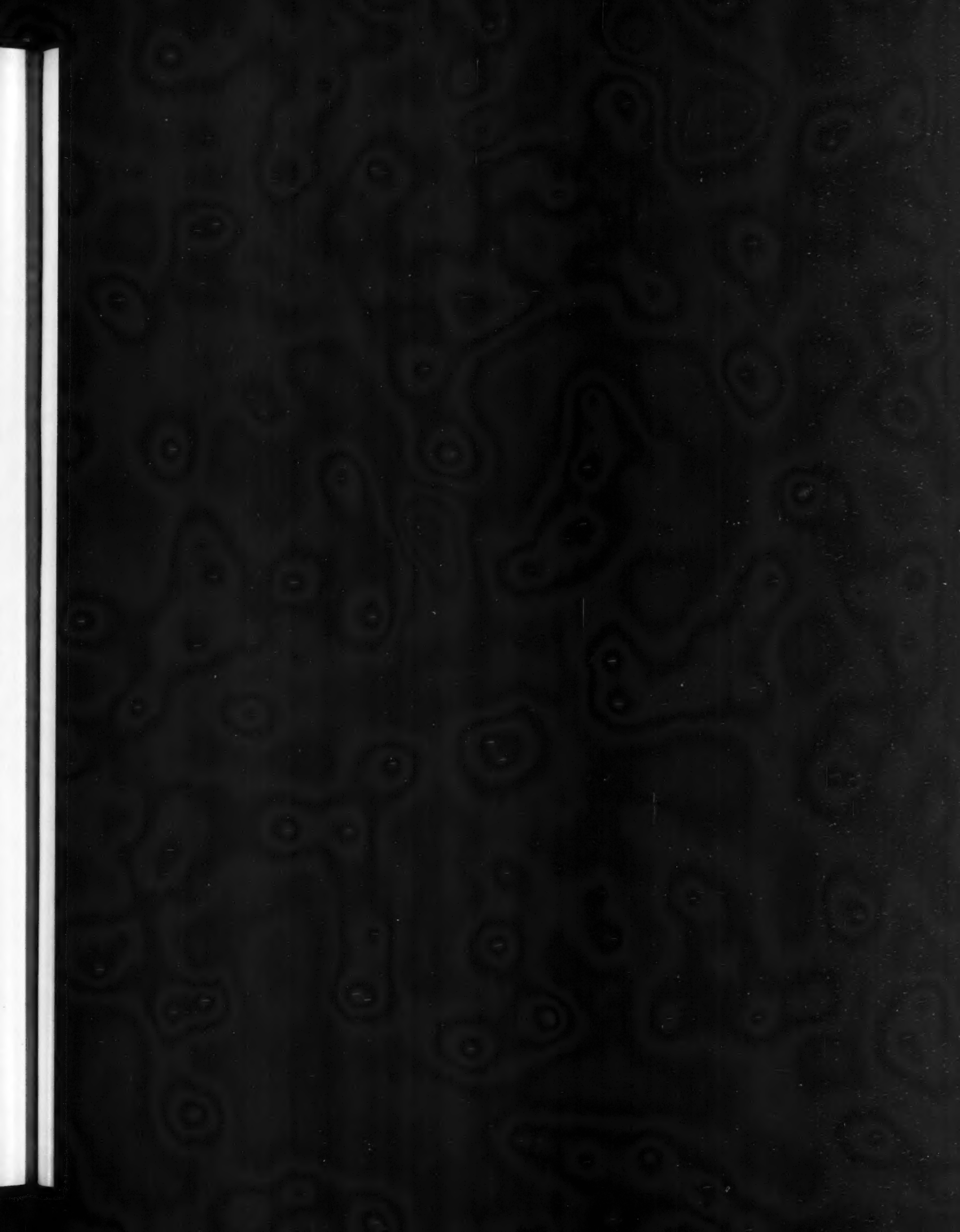

# The Journal of Electricity, Power and Gas.

Devoted to the Conversion, Transmission and Distribution of Energy.

VOLUME XIV. SAN FRANCISCO, CAL., MAY, 1904. NUMBER 5


## *On High Tension Transformers and Switches.*

### *Some Phases of Two Vital Subjects as Discussed by Members of the American Institute of Electrical Engineers.*

### THE RELATIVE FIRE RISK OF OIL AND AIR BLAST TRANSFORMERS.*

*BY E. W. RICE, JR.*

Of the transformers which have been extensively used in electrical installations up to date, two specific types are distinguished by the method of insulation and cooling employed. The "oil transformer" relies upon oil as the cooling and insulating fluid. The "air blast transformer" contains insulation material mainly of cloth, paper and wood impregnated with oil or varnish, and is cooled by the circulation of a blast of air. In both types the insulating material is of an inflammable nature, and under certain abnormal conditions may take fire with more or less serious consequences. The electrical engineer must, therefore, consider carefully not only the relative but the actual fire hazard which exists, and by proper and common sense methods minimize such danger. Both types can be made entirely safe by correct methods of design and installation.

I think it will be admitted that in general that type which contains the greater quantity of inflammable material will occasion the greater fire hazard. The inflammable material in an air blast transformer of say 1000 kilowatts capacity will amount to about 800 pounds, and in an oil cooled transformer of the same capacity the amount will be about 7300 pounds. While this comparison cannot be taken as a measure of the relative fire risk, it is an indication to be considered, especially in view of the fluidity, the low temperature of ignition and high calorific value of oil.

While the quantity of inflammable material in an air blast transformer is, as stated, relatively small, it has an extended surface exposed to a large volume of air, and, therefore, if a fire starts from internal causes, such as short circuit or extreme over load, is capable of rapid combustion. This combustion could be checked by shutting off the flow of air to a transformer by means of a diaphragm automatically closed by the melting of a fusible link, the fusible link so located as to be melted by the first contact with flame—a method similar to that employed for closing fire doors in buildings.

An oil transformer properly cooled is probably not particularly subject to ignition of the oil from internal burn-outs or arcs. It is well known that oil is an excellent medium for the smothering of alternating arcs, and this principle is utilized in connection with oil switches.

The vapor above the oil may, however, be ignited by electrical discharges. Even in this case, while the quantity of combustible material is enormous, the surface exposed is relatively small. The principal fire hazard in an oil transformer is due to the large mass of inflammable liquid material which under certain conditions may become totally consumed. It becomes a special hazard in the case of fire from sources external to itself.

Considerations of first cost, economy of space, simplicity, operating costs, etc., have resulted in placing transformers in the same room with switchboards and other apparatus, such as synchronous converters, motor-generators, etc. Under such conditions it would seem that the air blast transformer constituted the lesser fire risk than the oil transformer, and would therefore be generally employed if the fire risk were the only consideration. The air blast type, however, is limited in practice to pressures of about 30,000 to 35,000, as the static discharge which occurs at much higher pressures would in time break down the insulation. It is therefore necessary to employ oil insulation on the higher pressures now common.

The fire risk can be practically eliminated by placing such transformers in a room or rooms separated by suitable fire walls from the other part of the plant. This plan has already been proposed and introduced. An entirely separate building, subdivided again into suitable rooms, may be employed where the maximum of safety is demanded. Much may be done to limit the risk, even when the transformers are placed in the same room with other apparatus, by proper systems of piping for drainage of the oil away from the building, by placing the transformers in a depressed area of concrete arranged for rapid drainage, etc. Of course, any of the methods commonly employed for preventing, limiting or extinguishing oil fires may properly be employed.

In closing, I wish to state that I consider a discussion of this subject both timely and important. It is well for engineers to consider carefully the dangers of all kinds, both to life and to property, that may exist in connection with the use of electrical appliances. The art is not advanced by ignoring or belittling the existence of real difficulties, but rather by intelligently facing the problems which occur and seeking a proper solution. Electrical energy is capable of being produced, handled and transmitted more safely than any other form of energy, and such dangers as exist usually can be foreseen and safe remedies can be applied. On the other hand, we must not exaggerate the danger of fire from the use of transformers of either the oil or air blast type. I believe the fire hazard is extremely small, and can be and is being reduced to a negligible quantity by the adoption of methods similar to those I have outlined here.

*An introduction to a discussion presented at the 185th meeting of the American Institute of Electrical Engineers, New York.

# THE USE OF GROUP-SWITCHES IN LARGE POWER PLANTS.*

BY L. B. STILLWELL.

In a number of large electric generating plants recently designed in America, the feeder circuits are divided into a plurality of groups, and a switch designated a "group-switch" is connected into the circuit between the main busbars and each group of feeders. Obviously, no switch should be added to an organization of switch gear already very complicated and expensive, unless its practical usefulness fully justifies its adoption. This subject has never been discussed by the Institute.

In considering a subject such as this, accurate generalization is difficult, if not impossible. Probably no one who knows what engineering means would affirm without qualification either that he approves the use of group-switches or that he does not approve their use. There are few hard and fast rules in engineering. If such matters as the use or non-use of group-switches could be settled once for all, and for all plants regardless of size, function or attendant conditions, the purchasing agent would soon succeed the engineer, the pharmacist would take the place of the physician, and the capitalist investing his money in electric power development and use would have no occasion to seek among technical advisers for sound judgment resting upon broad experience and exercised in full knowledge of the existing state of the art, as well as recognition of its general direction and tendency. Instead of attempting a generalization, therefore, we may consider more profitably the arguments for and against the group-switch in the case of a typical plant, and then glance at some of the modifications of function and circumstance, which in the case of other plants would affect our conclusions. The group-switch first appeared in the plant of the New York Street Railway Company at Ninety-sixth Street, but as the writer had nothing whatever to do with the designing of that plant, he selects for consideration the plant of the Manhattan Railway Company. In this plant two complete sets of main busbars are used. Switches are provided, by means of which each of these sets may be divided into two independent sets of busbars, to each of which four alternators and four groups of feeders may be connected. Eight group-switches are provided, through each of which current is supplied to a set of auxiliary busbars, to which in turn the individual feeders are connected through their respective switches. One of the eight feeder groups is used to supply power to auxiliaries in the power house. The other seven groups supply power, respectively, to the seven substations which receive power from this central source. All switches in the high pressure alternating current circuits are of the motor-operated oil type.

The arguments in favor of the group-switch, as used in the plant of the Manhattan Railway Company, are:

First—It affords an additional means of opening a feeder switch that fails to open its circuit, when operated for that purpose. The advantages of the group-switch in respect to this function today appear materially less than they did five years ago, for the reason that the power-operated oil switch within the period named has demonstrated a high degree of reliability. However, it cannot be assumed that the feeder switch is invariably reliable, and, therefore, judgment of the weight of the argument in favor of the group-switch, based upon its use as a reserve for the feeder switch, becomes a question of judgment of the chances of failure of the feeder switch on the one hand and the seriousness of total interruption of power supply on the other.

Second—It affords means of reducing aggregate load upon the power house in case of necessity, more rapidly and otherwise less objectionably than the usual method of cutting off individual feeders. It will sometimes happen in the operation of a power plant that it becomes necessary to suddenly shut down one of the generating units. If the load carried at the time be such that the shutting down of the generator implies reduction of the external load, this can be accomplished most conveniently by operating one or two group-switches.

Third—Where duplicate main busbars are used it facilitates transfer of load from one set to the other, in case it becomes necessary suddenly in operation to make such transfer. As busbars and connections are now installed in our best plants, this necessity does not arise frequently; nevertheless it is liable to occur, and obviously half a dozen group-switches may be used to affect the transfer in much less time than would be required were five or six times that number of individual feeder switches used.

Fourth—The grouping of the external feeder-circuits in group units bearing a simple fixed relation to the generator units establishes a symmetry and proportion most useful to the operator, particularly in times of emergency. In the case of the plant under consideration, at times of full load, the power passing through each group-switch is substantially equal to the output of one generating unit. This relation, of course, does not exist under partial loads, but under such loads it is not difficult usually to keep in service generating capacity exceeding the load by a margin sufficient to make it possible to shut down one generator without cutting off feeders; and in cases where this margin of capacity is not kept in service it is, nevertheless, a more speedy and certain operation to cut off the necessary number of groups of feeders than it would be to cut off a proportionate number of individual feeders.

The arguments against the group-switch are:

First—It introduces additional apparatus, and, therefore, in itself increases the risk of interruption due to failure in switch insulation, etc. The successful operation of many plants, particularly in America, has been interfered with by the introduction of too much switch gear and too many safety devices, automatic and otherwise; these additions in themselves being responsible in some cases for more trouble than they prevent; and it is to be noted that the group-switch implies the auxiliary busbar. Here again it is impossible to dogmatize, for as the result of additional experience the judgment of today may be reversed five years from now. As an expression of personal opinion, however, I may say that if the group-switch and the auxiliary busbars be reasonably well insulated and installed, the interruptions originating in this additional apparatus should be almost negligible in the case of such a plant as that which we were considering.

Second—The group-switch and its busbars imply, of course, an increase of cost of the plant. In case of the Manhattan plant, this increase is about 10 per cent. of the cost of the switch gear and measuring apparatus, and about four-tenths of 1 per cent. of the cost of the plant. To put it another way, the cost of the group switches and busbars for the plant approximates $20,000, and the annual cost, assuming this to be 10 per cent. of the investment cost, is $2000, which is about two-tenths of 1 per cent. of the annual cost of operating the entire plant, including substations.

In the plants in which the feeder unit equals or exceeds the dynamo unit of power, the group-switch, of course, disappears. In this case, however, it may still be advisable to use two feeder switches in series in order to avoid the necessity of shutting down the entire plant in case of the failure of a single feederswitch.

Obviously, also, there is no reason for attempting to use group-switches in cases where the total number of feeders is small.

For plants comparable in magnitude to the plant of the Manhattan Railway Company, using a very considerable number of feeders, the group-switch is important and its use generally advisible.

*An introduction to a discussion presented at the 185th meeting of the American Institute of Electrical Engineers, New York.

## OIL SWITCHES FOR HIGH PRESSURES.*

*BY E. M. HEWLETT.*

A comparison of the oil-break switch with the air-break switch is the natural purpose of this brief paper. In treating this subject the following points appear to be the main points for consideration:

First—Abnormal Rise in Pressure: Owing to the fact that in oil-switches the circuit is opened at the zero point of the wave, the rise of pressure found in the air-break switch is not experienced. This point is of particular importance in high pressure, long distance lines, and in cables carrying considerable energy.

Second—Capacity: Experience has proved that oil switches may be designed to break circuits of practically unlimited capacity.

Third—Length of Arc: Owing to the smothering action of the oil on the arc the length of arc under oil is only a fraction of its length in air.

Fourth—Insulation: The insulating qualities of the oil decrease the distance required to prevent leakage and arcing.

Fifth—Size of Switch: Owing to the fact that the arc length is materially decreased and the value of the oil as an insulation reduces the creeping surface, an oil switch can be made very much more compact than an air switch.

Sixth—Remote Control: The design of the oil switch lends itself readily to operation by control from a distance.

Seventh—Arc Confined: The fact that the arc is ruptured under the oil within the switch has two advantages—first, switches can be placed close together without danger of short circuit; second, in case of emergency confusion is avoided, as there is no visible arc to disconcert the attendant.

Eighth—Station Arrangement: The flexibility of the oil switch places no limitations on the station arrangement, permitting the circuits and busses to be arranged in the most advantageous manner.

Ninth—Isolation of Phases: The possibility of complete isolation of the phases in a reasonable space is easily secured by the use of oil switches.

*An introduction to a discussion presented at the 185th meeting of the American Institute of Electrical Engineers, New York.

## TERMINALS AND BUSHINGS FOR HIGH PRESSURE TRANSFORMERS.*

*BY WALTER S. MOODY.*

This subject will include cables, straps, connectors, etc., for both high and low tension side, designed both for terminal connections and for changes in the ratio of transformation, together with their insulation. In transformers for moderate pressure and having but two high and low pressure terminals, the problem of terminals is a simple one; with higher pressures and numerous changes in the ratio, however, the design of these parts of the transformer often becomes a most difficult problem, upon the proper solution of which depends, to no small extent, the reliability of the transformer.

It is much better to have the high and low pressure terminals at opposite ends of the structure, for it is almost impossible to keep safe distances between the terminal and connecting coil leads, when all are at one end. In a shell-type structure, having its coils in vertical position, this requires one set of coil terminals to be at the bottom of the case, but to bring these safely to the top is not as difficult as to separate high and low pressure conductors that are at the same end of the windings.

In an oil-immersed transformer the insulation of terminals on coils presents little difficulty, as it is simply necessary to have all leads rigidly spaced a safe distance from each other and from the coils, and covered with sufficient waterproof insulation to prevent any moisture penetrating the coil around the terminals before the oil is put in.

In air blast transformers, however, the case is different; here all terminals must be covered with an insulation integral with that on the coil itself, to a distance from the coil that provides sufficient surface insulation, even when the lead is well covered with dust and dirt.

Often the dielectric strength of a transformer is materially lowered by allowing the coil terminals or taps to project beyond the sides of the coils, thus shortening the distance between the primary and secondary. "Spreading" the exposed ends of the windings removes this difficulty, except when the terminal comes from a point well within the coil, but introduces a more serious defect —lack of rigidity to withstand the strains of short circuits. Usually the problem can be solved by so winding coils as to have only ontside terminals and locating such coils as have taps on the outside of the coil structure.

The best location for main terminals naturally varies with the type of transformer and its pressure. For the air blast type the air chamber forms a convenient and natural location for the low pressure wiring, and the terminals of these are therefore usually located in the base of such transformers and made accessible by doors in the side of the base. For pressures not exceeding 25,000 volts the high pressure wiring can also be placed in the air chamber, without making the air chamber of excessive cross-section, so that all transformer terminals are in the base and exposed wiring is avoided. Heavy rubber insulated cable is to be avoided in such construction, however, for should the rubber take fire from short circuit or other causes a draft of air will carry the fire along the duct and into the transformers with great rapidity.

In oil filled transformers the terminals are, of necessity, located at or near the top of the case. Often for convenience in external wiring projecting pockets are provided through which terminal leads may leave the case in a downward direction. With such construction, it is necessary to have a solid section in the cable, just above the oil line, and to have this section uninsulated or covered with an insulation impervious to oil, otherwise the cable and insulation will act as a siphon and discharge oil.

Below 40,000 volts the insulation of high pressure terminals offer no special difficulty; porcelain or glass bushings can readily be obtained that are safe for this pressure, even if the conductor has no insulating covering. For higher pressures the problem is more difficult, if no insulation is used on conductor, the bushings become expensive and so large that there is scarcely room on top of a moderate size transformer for as many terminals as are often required. The following are some of the more common forms of bushings that have been used:

Wooden tubes.

Hard rubber tubes.

Glass and porcelain tubes, both single and concentric.

Numerous forms of molded porcelain bushings.

Wooden tubes of the necessary size cannot be thoroughly dried and filled. Hard rubber is so apt to contain impurities that it is unsatisfactory; moreover, it deteriorates rapidly if ozone is generated near it. Glass is fragile and must be protected with other semi-insulators. Porcelain, or any smooth tube, must be very long if it have sufficient leakage surface to be safe when dirty, and even the best shapes of corrugated bushings are large and expensive when capable of withstanding a test of from 75,000 to 160,000 volts.

All things considered, the writer has found the following practice quite satisfactory for test pressures not exceeding 160,000.

Insulate the lead with varnished wrappings that will safely withstand for one minute about half of the test pressure to be

*An introduction to a discussion presented at the 185th meeting of the American Institute of Electrical Engineers, New York.

applied, bringing out this lead through a porcelain bushing having the same strength as the insulation of the lead, and sufficient surface to prevent leakage at this pressure when dirty; in other words, let the insulation of the leads be sufficient for the working pressure, and the porcelain be of such strength as to give the factor of safety desired. This combination forms a far safer insulation than a bare conductor and a larger bushing which would stand the same puncture test as the combination, from the well-known fact that oxidized linseed oil is an insulation that will momentarily stand several times as much as it will for any considerable length of time, while porcelain, glass, etc., have no such time factor.

In leads requiring a test of 100,000 volts or more, and insulated in this manner, an additional difficulty is met in the induced charge on the outer surface of the insulation; at this pressure the surface is covered with a heavy brush discharge that so reduces the surface resistance to leakage that 100,000 volts will travel along several feet. It is usually impracticable to make the insulated lead long enough to withstand the pressure under these conditions, but the discharge may be broken up, so that it will not appreciably reduce the surface resistance, by bell-shaped pieces of rubber, porcelain or other insulation slipped over the lead before all the varnished wrappings are put on, and having its small end so shaped as to allow of its being burned in the outer wrappings.

In transformers designed for Y-connection and grounded neutral, some transformer builders, in order to save expense on high-pressure bushings, have grounded one terminal on the case and insulated only such leads as are to be connected to the line; this prevents operation with △ connections, but otherwise seems unobjectionable. In similar manner the use of three-phase transformers, with the inter-connecting between the phases made within the case, reduces the expense and possibility of trouble with bushings.

Eighty thousand volts is the highest pressure that is now practicable for transmission work, but transformers and insulators must be tested, consequently there is some demand for transformers working up to 200,000 volts. The insulation of the terminals of such transformers is the most formidable part of their design. As yet, I know of no satisfactory solution of the problem except to use oil-filled tubes as terminals.

A terminal that has withstood 375,000 volts without any indication of weakness is constructed as follows: The tube was the shape of two truncated cones, bases together; about twelve inches in diameter at the center and four inches at either end; it was built up of thin wooden rings, telescoped a short distance into each other, and held together by the conductor, which, for mechanical purposes, was made quite heavy, and which was located in the axis of the cones and supported by washers at either end of the tube; between each section of the tube were collars of insulating material some three inches larger in diameter than the tube, which served the purpose of greatly increasing the leakage surface. After the sections were drawn tightly together by nuts at each end of the conductor, the whole structure was repeatedly dipped in varnish and dried, thus sealing all joints. The terminal was mounted with the lower end several inches under the oil in in the transformer, and with its largest diameter on a level with the cover; the lower end of the tube was tightly sealed, making the tube perfectly oil-tight.

At present we are passing through a period of development in line construction. Each engineer of a new transmission system of considerable length desires to use as high pressure as possible with a line construction of reasonable cost, but few are sure whether fifty, sixty, seventy or eighty thousand volts is the safe maximum for their conditions. It is common, therefore, for the manufacturers to be asked to make transformers that can be operated at several voltages on the high-pressure side. The result, whether accomplished with series-multiple connection, changing from delta to star, or simply by taps, usually requires so many terminals that it becomes quite impracticable to place all the necessary leads outside the case, even were it desirable to do so; consequently, acccssible terminals inside the case must be provided. Again, at these and lower pressures, also, it is usually desirable to provide for limited range of adjustment in the ratio, say by 2 per cent., with a total of 10 per cent. Such changes are usually too small to be made except by means of taps on the high-pressure windings. Except on transformers of very large capacity, there would be no room safely to insulate so numerous terminals above the surface of the oil; the practice is therefore to locate such terminals just under the oil and make them as accessible as possible, either by the removal of the transformer top, or through an auxiliary cover on the top of the case. It is better that each of these terminals be separately supported by glass or porcelain insulators, for a single support, such as a slab of marble, is almost sure to collect sufficient semi-conducting material to cause trouble sooner or later. Such terminals being, at the best, rather inaccessible, there is danger that a wrong or imperfect connection will be made when changes are desired. The following method of mounting transformers in the tank greatly simplifies the problem of getting at such terminals, especially when transformers are installed under a crane. Instead of supporting the transformer proper on the base of the case as usual, it is hung from a strong cover; the interior terminals are placed in about the usual position, but are supported by the bolts carrying the transformer. To get at these terminals it is then simply necessary to raise the cover with the transformer, until the terminals are on a level with top of case; connections may then be made with convenience and safety and the transformer returned to its position in the tank.

Usually low pressure terminals present no special difficulties. When transformers are connected in multiple and deliver 500 amperes or more, special caution should be taken that all joints are soldered or that terminals are of such construction as to have extremely low contact resistances. Taper plugs and receptacles are perhaps the most reliable form of contact for the purpose.

Current in excess of 500 amperes should never be brought out through separate openings in the case, otherwise there will be local heating around the terminal and needless reactance introduced into the circuit. Currents over 2500 amperes should be brought out by means of intermixed busbars for the same reason.

## THE DISCUSSION.

The discussion was opened by C. C. Chesney, Pittsfield, Mass., who divided the high-tension switches into four types: Switches designed to break in the open air; second, in an inclosed space; third, with the aid of an inclosed metal fuse; fourth, under oil. The objection to the first type is that a large space is required to make the operation sure, and there is apt to be a high rise of potential upon breaking an arc. Type two is a decided improvement over type one, but the explosion on opening heavy circuits with this switch is often dangerous, affecting not only the switch, but all neighboring instruments. Type three will open safely almost any circuit at almost any potential, but is limited by the amount of space required and the powder sent flying by the explosion of the arc. Type four has been recognized within the past year as the only switch for high tension work.

Contrary to the general expectation, the opening of a circuit by an oil switch is not a quick break. The oscillograph shows that the arc continues for several periods, going out, as a rule, at the zero point of the wave. Oil switches for 40,000 volts must have a depth of oil four or five inches over the terminal of the switch. This type of switch is divided into two classes, the plunger breaking the arc in a vertical plane, and the other breaking it in a horizontal plane. The latter type has been used a good deal on the Pacific Coast. Mr. Chesney described a number of experiments which had been made with oil switches, during which circuits coupled to generators rated at 11,000 kilowatts, with a line potential of 45,000 volts, had been short circuited and then opened successfully.

A number of points to be considered in designing oil switches

were then given. The oil should have a flashing point of 215 degrees centigrade, a fire test of 250 degrees centigrade, a specific gravity of 0.865, and should be neutral. The terminal bushings should be either glass or porcelain. The switches should be placed at some distance from the switchboard and other apparatus. All the switches should be controlled either mechanically or electrically, all of the poles of a switch being operated simultaneously. It is also desirable to equip each switch, especially if it is automatic, with a time element attachment, so that the circuit cannot be opened for at least a second after the operating mechanism is set in motion.

Dr. F. A. C. Perrine, Pittsfield, Mass., described tests which he had conducted with oil-break switches at San Jose, Cal., ninety miles from the electric power station of the California Gas and Electric Corporation. The line was operating at 40,000 volts, and was short circuited and opened by means of switches. The tests had to be discontinued on account of a severe rise of potential, which threatened to injure the machinery and the line. This was so great that discharges took place across the lightning arresters through an air gap of nine inches.

Dr. Perrine differed from the conclusions in regard to the relative fire risk of oil and air blast transformers. He described three fires through which transformers of the oil type passed. In those cases in which the oil was retained within the case the transformers were undamaged. Where the oil was allowed to flow out, either through upsetting or the giving way of the case, the transformers were damaged. He thought that the fire hazard depended more upon the distribution of the inflammable material than upon the amount. It was important to construct the cases strong enough to resist damage from falling bodies. Provision should be made to protect water cooling pipes so that circulation might be kept up during the fire. He recommended the installation of transformers in pits which could be filled with water, but not high enough to flow into the transformers. He thought it unwise to attempt to draw off the oil during a fire.

J. S. Peck, of Pittsburg, Pa., had found that the air blast transformer is subject to a greater fire risk than the oil type, but, due to the fact that the insulation of the former is in solid form and relatively small amount, it is possible to have such material entirely destroyed with little danger to neighboring apparatus.

There are two sources of danger from the use of oil: The oil itself may take fire, or a vapor may be given off which, when mixed with air, forms an explosive mixture. The nature of the second danger is not generally understood. It has been found that with the best proportions of illuminating gas and air under atmospheric pressure, the greatest pressure which can be obtained from an explosion is somewhat less than 100 pounds per square inch. It is probable that the best mixture of oil, vapor and air would not give a force more than this. Transformer cases should consist of sheet iron with a tight cover sufficiently strong to withstand this pressure. Where a self-cooling sheet iron case must be used, it is impossible to make this sufficiently strong to withstand the internal pressure of 100 pounds, and in such cases a large safety valve should be provided. Mr. Peck described the fire which destroyed the transformers in the transformer house and threatened the power house at Snoqualmie Falls, and he thought that provision should be made for drawing off the oil from the case should this become necessary.

Calvert Townley, of New York City, did not believe that either type of transformer was an extreme fire hazard. High voltages increase the fire risk, but everything possible is done to decrease it. It is a mistake to allow the fire risk to be magnified in the public mind. The air blast transformer, having but a small amount of conducting material, has, in very few cases, caused serious fires. The chief danger from this type is the presence of the blast of air, which, should a fire start in the transformer, may spread it to other apparatus. This danger should be provided for by properly discharging the air. The air blast transformer is more subject to damage from external fires than the oil type, because its case is not fire-resisting and is apt to become soaked with water used to extinguish the fire. He cited an instance where the transformers in a station were put out of service for several days for this latter reason, although they had nothing whatever to do with the fire. He regretted the use of the word "oil," which is generally connected with the idea of highly combustible material; but he suggested no other term. Both types of transformers are equally good, and each fills a particular field. There is therefore no need to take a stand in favor of either type.

That the fire risk due to high voltages was greater than that at low voltages was not admitted by Ralph D. Mershon, of New York City, he believing the contrary to be true. The fire hazard depends upon the distribution of inflammable material more than upon the quantity. It also depends upon the provisions taken for coping with fire. Mr. Mershon is in favor of bare high voltage wiring in all places, and for this reason objects to installing transformers in separate vaults. A perfectly fireproof wall makes wiring difficult. He thought it was dangerous to attempt draining the oil out of transformers from the bottom, and described a system recently adopted by himself, in which the oil is forced out through a pipe at the top of the case by means of water let in from below.

Mr. Mershon thinks that group-switches are rather unnecessary now, as the oil-break switch has proved so reliable. Under some conditions he thought the air-break switch filled a need, because of the cost of the oil-break type and the complications necessary in installing it and wiring for it. If an oil-break switch could be located overhead with the wires the conditions would be much simplified. He did not believe that the marble terminal board has any place in high voltage transformers.

Some of the difficulties in designing high tension transformers were explained by C. E. Skinner, of Schnectady, N. Y., emphasis being laid upon the complications caused by requiring many terminals. Special bushings for high tension terminals cannot be made of wood alone, and hard rubber tubes deteriorate rapidly. Glass and porcelain are mechanically fragile, and it seems next to impossible to get molded porcelain of sufficient dimensions for the high voltages now used. If the transformer tank is not required to withstand a heavy pressure, a satisfactory construction consists of fastening a slab of insulating material, such as marble, on the top of the cast-iron cover, into which heavy tubes with sufficient extension to give the necessary surface insulation are placed. Tubes for this purpose may be made up of alternate layers of varnished paper and mica. In one instance, where the line voltage was 50,000 and the transformer case was required to withstand 100 pounds per square inch, the marble slab was omitted and extra heavy bushings were made, which passed through stuffing boxes. Oil-filled transformers should not have too high a flash test, on account of the great viscosity, which reduces the power to conduct away the heat. A well-constructed case, with a cover which is fireproof, and which can be made practically air-tight, with fireproof compartments with means for draining, will reduce the fire risk of oil-insulated transformers to a minimum.

The use of group-switches is regarded by H. G. Stott, of New York, as additional insurance, and the more expensive the plant the greater is the expenditure which may be allowed for this purpose. The reliability of the oil-break switch is illustrated by the fact that in more than two years' operation of the Manhattan Railway, with 160 oil switches, no failure has occurred, although short circuits have taken place which developed about 100,000 kilowatts. Mr. Stott emphasized the need of employing only cool-headed, reliable attendants. It is important to have highly skilled attendants on all high tension apparatus.

P. M. Nunn, of the Telluride Electric Light and Power Company, Telluride, Col., stated that his company is now replacing all the air switches by oil switches as rapidly as possible, even in small stations, partly on account of the interruptions caused by the peculiar effect due to the air switch, and partly because air switches are not made automatic. He thought we could not afford to overlook the danger of the oil in the transformer cases.

He believes that the risk is great, and his personal experience during the last ten years has not warranted him in feeling that he can afford to overlook this risk and fail to employ all reasonable precautions, and some which eventually would be called unreasonable. This company has lost two substations—everything except the brick walls—and while there is no evidence that the fire originated in the transformers, it was the oil which caused the loss. He thinks that in some respects the air blast is better, but manufacturers of transformers are not prepared to supply air blast transformers for the higher potentials. He suggests that some one devise a transformer in which non-inflammable, non-combustible gas may be circulated in place of the air.

P. M. Lincoln, Pittsburg, Pa., thought that the risk due to air blast transformers is greater than that due to the oil type, because, in the latter case, the oil cannot take fire unless supplied by air, while in the air blast transformers conditions are very favorable for fire should sufficient heat be developed at any point. He thought that the automatic damper suggested in Mr. Rice's paper could not be relied upon. When properly installed neither the air blast nor the oil insulated transformer can be considered a serious fire hazard.

C. L. de Muralt said that in European practice the air blast type is considered a greater fire risk than the oil type. The oil type heats more slowly under overloads, which allows time for the safety devices to operate. In Europe air cooled transformers are not generally made in sizes larger than 150 kilowatts. He thinks that the oil transformer can be made almost fireproof, and it is a good plan to put them in separate buildings, and that this need not necessarily complicate the wiring. In the case of hydro-electric plants the building is usually long, and if the switchboard is placed near the center of the long side the transformers may be placed in the room back of it, to which the leads pass from the switchboard. Any switches needed in this room may be operated mechanically from the switchboard, and there is no need for switches on the high tension side of the transformers. If transformers are placed in a separate building, in strong iron boxes or castings made of boiler iron riveted and caulked, strengthened by angle irons and well covered with a tight fitting cast iron cover, there is absolutely no fire risk either from the inside or the outside. Mr. de Muralt described an air-break switch which resembles the Dutch horn type of lightning arrester, and which is being adopted considerably in Europe. One of these switches has successfully broken a current representing 1500 kilowatts.

A time-limit switch was described, the action of which depends upon a relay. The circuit of the relay is closed by a small weight which is wound up by a rotating field acting upon an aluminum disk. The greater the overload, the more quickly is the switch tripped. If the overload goes off before the switch is opened the weight returns to its original position.

O. S. Lyford, Jr., of New York City, thought that too much emphasis could not be laid upon the fact that, although transformers are fire risks, the risk is not so great that it cannot be met. Transformers should be divided into three classes—oil insulated water cooled, oil insulated air cooled, and air blast transformers. Each type fills a particular field. Thus, in a small substation where water is not available, the air cooled type should be installed, as a blower equipment would be an unnecessary nuisance. He laid stress upon the necessity of making a station building entirely fireproof.

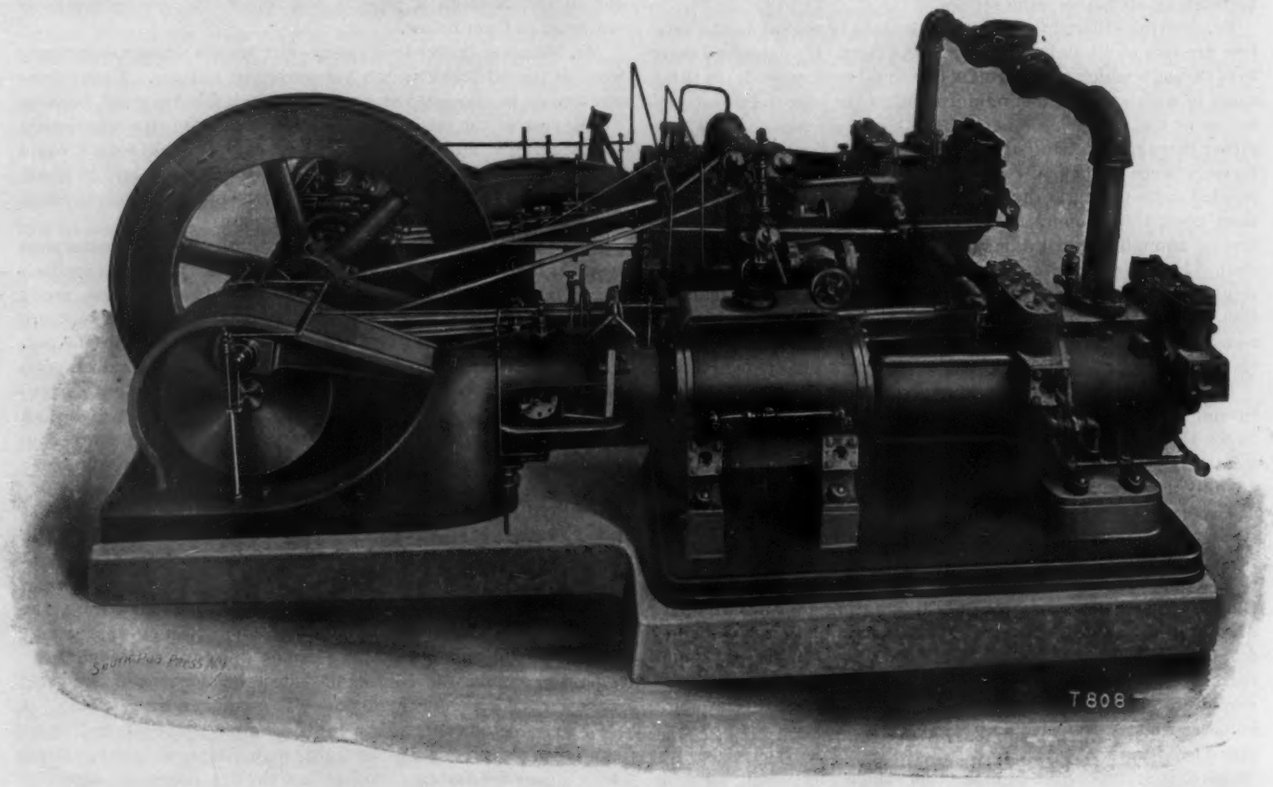


FIGURE 1

L. B. Stillwell, replying to the discussion, said that the auxiliary group-switches for the Manhattan power station cost $2000 a year, allowing 5 per cent. for interest and 5 per cent. for maintenance. This plant, during rush hours, earns $5000 an hour, and any precaution which decreases the risk of a shut-down is advisable. It would be better to install double switches for this station, rather than have three shut-downs in the course of a year.

## THE COMPRESSED AIR PLANT AT THE ST. LOUIS EXPOSITION.

THE central compressed air power plant at the St. Louis Exposition will contain two main compressing units, one cross-compound, two-stage, Cincinnati gear compressor, having thirteen and twenty-four-inch steam cylinders, twenty-two and fourteen-inch air cylinders and twenty-four-inch stroke, with

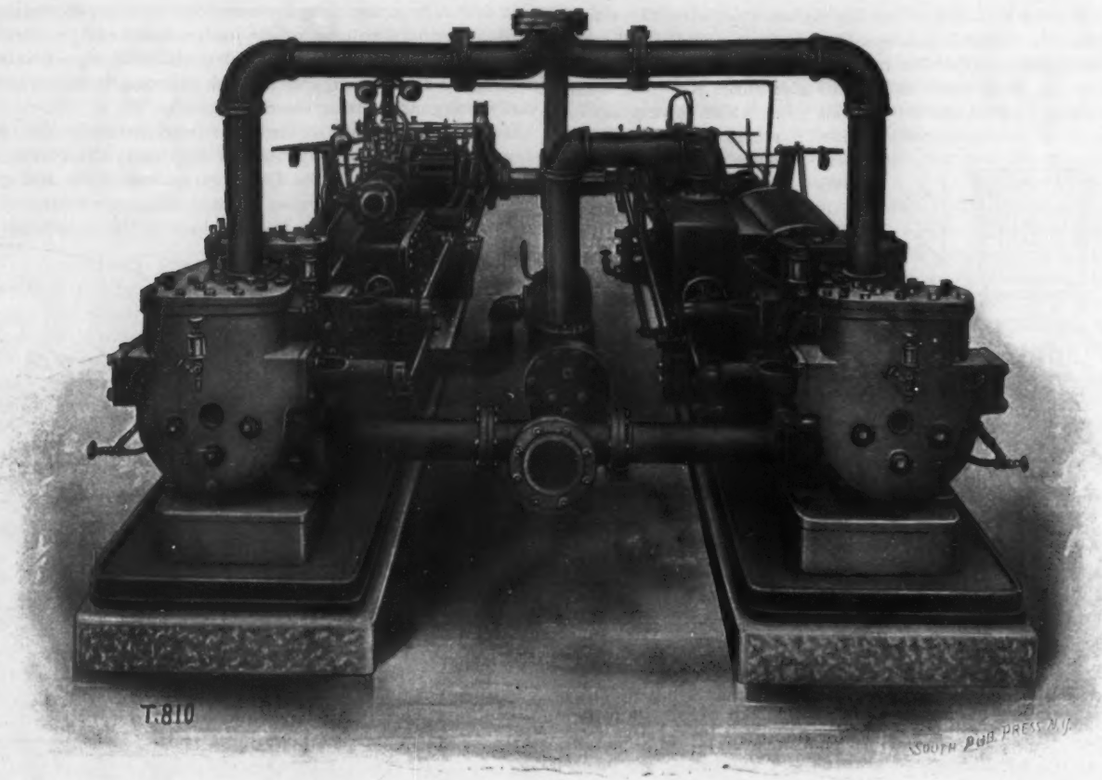


FIGURE 2

a displacement at 125 revolutions per minute of 1300 cubic feet per minute, and one cross-compound, two-stage, Meyer gear compressor having twelve and twenty-inch steam cylinders, eighteen and eleven-inch air cylinders and eighteen-inch stroke, with a displacement at 100 revolutions per minute of 530 cubic feet per minute. The first machine is to supply the general compressed air requirements of the exposition, while the second is to supply the transportation exhibits. The larger machine is of special interest as being the first compressor of this type publicly exhibited, although a number of similar machines have been and are being installed in private plants. A 1500-foot machine is at the present time being placed in the Jersey City power house of the Central Railroad of New Jersey.

The general construction of one of these machines is shown in Figures 1 and 2. The frames, as will be noted, are of massive construction, with a long bearing on the foundation, while the steam and air cylinders, joined in the direct line of thrust by heavy cast iron housings, are also supported by bed plates under their entire length, the weight of each side being thus taken on two large bearing surfaces extending to the ends of the machine, avoiding the objectionable features of overhung cylinders and giving the compressor great stability. The general construction is characteristic of the best grade of engine work, and comprises removable quarter boxes and main bearings, steel forged connecting rods, with wedge take-up, specially large crank and wrist pins and cast steel cross-heads with adjustable babbitted slippers, top and bottom, working in bored guides. The reciprocating motion is of the simplest possible character, this simplicity in construction permitting low reciprocating works without sacrifice of strength. These features allow satisfactory balancing, and, in connection with the long bearing on the foundations, insure an especially easy running machine. The steam valve gear is of the four valve type. Steam distribution is effected by means of short, double ported, slide valves, working at either end of the steam chest on a valve face as close as possible to the cylinder bore, the port volume being restricted as far as the large valve area will allow. The exhaust valves are of the Corliss rotary type, and are placed at the bottom of the cylinder. This construction has been followed in

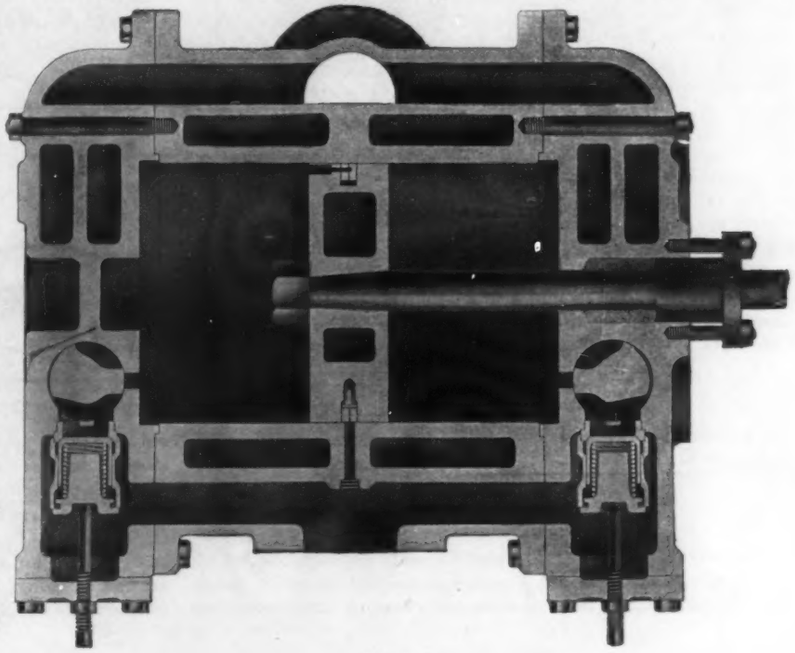

FIGURE 3

order to produce a valve gear having the essential advantages of a Corliss, namely, separate passages for the steam and the exhaust, with corresponding reduction in cylinder condensation, together with short, straight ports and small clearance. On the other hand, the complicated Corliss releasing gear, which is necessarily prejudicial to even moderate speeds, has been eliminated, the action being positive throughout.

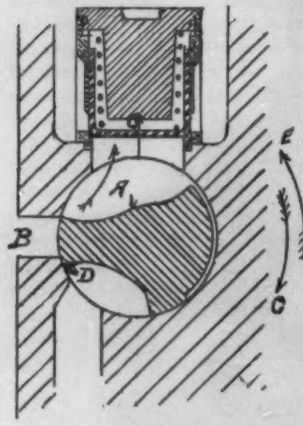

FIGURE 4

The air valve gear is, however, the distinguishing feature of this machine, combining in a very ingenious manner the positive action, noiseless operation and durability of the mechanically moved valve with the elasticity of the poppet valve. The noise and rapid wear of the poppet valve, due to the impact of the valves closing at the reversal of stroke, is eliminated by mechanically closing the passages underneath the poppet valve, and leaving a cushion of air upon which the latter seats. The action of the valve gear is clearly indicated by Figure 3, showing the general arrangement of the cylinder, and Figures 4, 5 and 6, showing the position of the valve at various points of the stroke.

At the beginning of the forward stroke of the piston, indicated by position 1 in Figure 6, the mechanical valve *A*, as shown in Figure 4, is just closing the port *B*, the discharge edge of *A* being in line with the upper edge of the port *B* and the valve moving in the direction shown by the arrow *C*. After the piston advances a short distance the valve has reached the position shown in Figure 5, in which the inlet edge of the valve *D* is just coming in line with the lower edge of port *B*. The valve continues to move in the direction of the arrow *C* until about mid stroke, when it reverses to the direction shown by arrow *E*, bringing the valve back to the position shown in Figure 5 at the end of the stroke, corresponding to position 3 on the ideal card shown in Figure 6. On the return stroke, the valve still moving in the direction of thearrow *E* returns at position 4, Figure 6, to the position shown in Figure 4, the discharge edge of valve *A* being in line with the upper edge of the port *B* and opening.

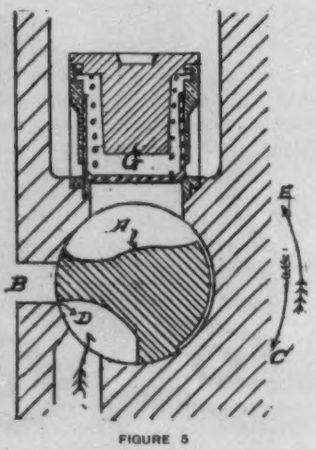

FIGURE 5

After the mechanical valve opens, the poppet valves *G*, which have had the entire return stroke in which to seat, prevent the flow of air back from the discharge passages to the cylinder, and remain closed until position 5 in Figure 6 is reached, when the pressure inside the cylinder slightly exceeds the pressure in the discharge passages. The poppet valves *G* thereupon open and remain open until position 1, Figure 6, is reached, at which point the valve *A*, which in the meantime has changed its direction to that shown by arrow *C*, has resumed the position shown in Figure 4, thus leaving a volume of air under discharge pressure in the space between the mechanical valve and the poppet valve, permitting the light springs back of the poppet valves *G* to seat them easily and gently during the return stroke.

FIGURE 6

It will thus be seen that the three fixed points in the compression cycle, namely, the opening of the inlet, the closing of the inlet and the closing of the discharge are positively and mechanically controlled; the opening of the discharge, which is the only variable point in the cycle, is controlled by the automatic poppet valves, which are relieved, however, of the necessity for quick closing, and are consequently free from the objectionable features of noise and rapid wear.

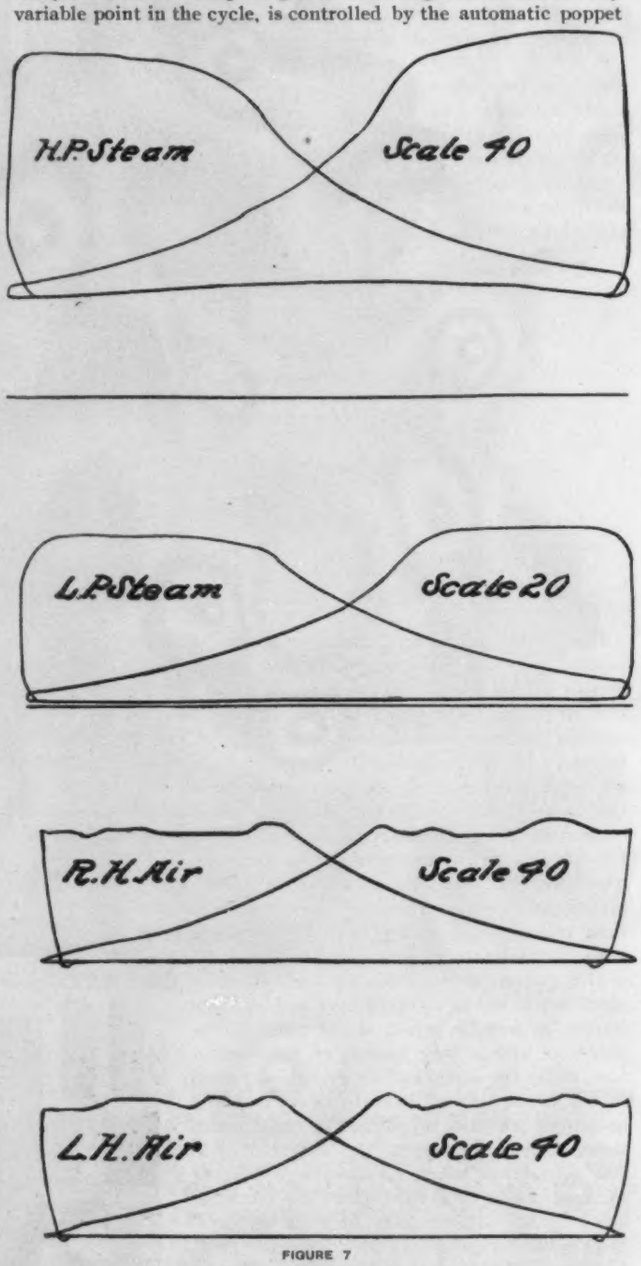

FIGURE 7

In Figure 7 are shown cards from one of these machines operating at a speed of 150 revolutions per minute, with steam pressure of 85 pounds and air pressure of 30 pounds per square inch. Attention is called to the steep expansion line on the air cards, indicative of the small clearance and high volumetric efficiency of

the machine, the large valve area being shown by the practical coincidence of the inlet and atmospheric lines and by the uniform discharge line. The rounded admission of the steam cards, which might in ordinary engines be deemed objectionable, is due to the maker's practice of giving the steam valves a slight negative lead to offset the expansion pressure at the beginning of the air cards.

These machines are built by the Laidlaw-Dunn-Gordon Company of Cincinnati, O., U. S. A.

## SUMMER SESSION OF THE UNIVERSITY OF CALIFORNIA.

WITH a faculty comprising specialists from the leading universities of America, and from London, Cambridge, Amsterdam and Stockholm as well, and with a list of courses of great variety and richness, the University of California will open its doors from June 27th to August 6th for its annual six-weeks summer session.

The summer session is planned primarily for persons of maturity who wish the stimulus of living for a time in a university atmosphere and of instruction from leaders in scholarships competent to bring their scholars in touch with the latest developments of knowledge and method in their special fields.

For science there will be a large assemblage of men who are opening new fields of knowledge. For chemistry there will come from London Sir William Ramsay, of University College, the chemist whose recent experiments with radium have resulted in what he regards as actual transmutation; for physiology there will be Professor Jacques Loeb, of the University of California, who has contributed much to the world's knowledge of the vital processes; for botany there will come from Holland Professor Hugo de Vries, of the University of Amsterdam, whose experiments have done much to shape current theory as to the origin of species; and Svante August Arrhenius, Professor of Physics in the University of Stockholm, will come from Sweden to lecture on physical chemistry, a science whose bases were laid by his discoveries on the modern developments of the serum treatment of disease, and on the theory of immunity. The scientific instruction by these and a number of other men will include astronomy, physics, chemistry, botany, zoology, physiology, mineralogy, physical geography, civil engineering, mechanical drawing, agriculture and entomology.

The provision for historical instruction is likewise striking. Professor Bernard Moses, recently returned from three years' service as a member of the United States Phillipine Commission, will lecture on "Political Dependencies" and on "Government." The Eastern question—the Balkans, Russia in Asia, and China, Korea and Japan—will be discussed by Professor Archibald Cary Coolidge, of Harvard, historian and diplomatist; Professor H. Morse Stevens will treat of English history, and American history will be taught by Professor Frederick J. Turner, of the University of Wisconsin, the first authority in his field.

For classics there will be Professor Morris H. Morgan, of Harvard, and Professor W. A. Merrill, of the University of California; for English, Hummond Lamont, managing editor of the New York *Evening Post*, and Professor Francis B. Gummere, of Haverford, an authority on old English ballads and on early English literature; for modern languages there will be Charles H. Grandgent, Professor of Romance Languages at Harvard; Fonger de Haan, Professor of Spanish at Bryn Mawr, and Professor Albin Putzker and Messrs. M. J. Spinello, C. W. Wells and L. J. Demeter, of the University of California. The distinguished philosopher, James Ward, a Fellow of Trinity and Professor of Mental Philosophy at Cambridge, will come from England to lecture on psychology.

To acquaint teachers with the best modern methods of instruction in their special fields will be the object of many courses in individual departments. Instruction in the theory of education as such will be offered by Professor Frank M. McMurry, of Teachers College of Columbia University. Dr. Reginald A. Daly, Geologist for Canada to the International Boundary Commission, will offer work in physical geography planned to be of particular value to teachers of the subject.

For music there will be Albert A. Stanley, Professor of Music in the University of Michigan, who will lecture on the history of music and on its relation to life, illustrating his instruction by selections from works of the most important epochs.

Thus, aside from the scientific courses, an equally rich range of instruction is offered in history, education, philosophy, political science, music, Greek, Latin, English, German, French, Spanish, Italian, Celtic and mathematics.

The unusual opportunities afforded by the cosmopolitan character of the faculty and the high character of the instruction offered has been greatly appreciated in past years, as was evidenced by last years enrollment of 868, a number of students which has been equalled only at summer terms at Chicago and at Harvard.

The summer climate of Berkeley makes it an ideal place to spend a vacation. The University is picturesquely situated on the lower slopes of the Berkeley hills, three miles back from San Francisco Bay and only thirty.five minutes distant from San Francisco, with a 10-cent fare. Five trains an hour make all the opportunities of a great city readily available. Ample accommodations are to be found in Berkeley at an expense of from $25 to $35 a month. Special round-trip rates of a fare and a third are offered by the Southern Pacific and the Santa Fe to attendants upon the summer session.

## WHY MUNICIPAL OWNERSHIP FAILS.*

*BY ALLEN RIPLEY FOOTE.*

A BILL is now pending before the Legislature of Indiana which presents a lesson to which the attention of all municipal ownership advocates should be drawn. It is to permit the sale to the highest bidder of a municipal lighting plant, a franchise for operating the plant to be granted to such bidder. The plant was constructed some years ago, and was seemingly successful for some time. Rates for service were considered high, and were lowered from time to time. It is suggested that desire for political favors from some large consumers led to fixing rates for them at specially low figures. To make a good showing for prompt collections 20 per cent. discount for prompt payment was made, even from these low rates. The result of all these bids for popular favor has been that, while the works have been operated in such a way as to pay expenses, there has been no proper provision for depreciation. A new administration finds a plant requiring thorough reconstruction and the correction of some errors in design, but finds no money with which to do the work, no credit on which to raise the money, the city's debt limit being reached, and no possibility of running the plant long enough at higher rates, admitted to be necessary, to replace the old machinery from the profits of the business. In despair at the situation the city officials have applied to the Legislature for an act to enable them to sell the plant to the highest bidder.

Enthusiasm for public ownership is probably at low tide in that city.

## THE INTERNATIONAL ELECTRICAL CONGRESS.

ANNOUNCEMENT is made that the following papers are promised for Section A—the section on "Theory" of the Congress—of which Professor E. L. Nichols is chairman and Professor H. T. Barnes is secretary.

*Foreign—*

Professor Dr. Paul Drude, "Metallic Conduction."

Professor Dr. W. Jaeger, "Electrical Standards."

Sir Oliver Lodge, F. R. S., "Ions."

Professor H. Nagaoka, "Magneto-Striction."

Professor Dr. J. J. Thompson, F. R. S., subject to be announced.

Professor J. S. Townsend, F. A. S., "The Theory of Ionization by Collision."

Mons. J. Violle, "Secondary Standards of Light."

C. T. R. Wilson, F. R. S., "Condensation Neuclei."

Professor P. Zeemann, "Magneto-Optics."

*Excerpt from an article published in *Municipal Affairs* on "Regulation and Taxation of Public Service Corporations," which is reproduced in *California Municipalities*, Volume VIII, page 300.

*American—*

Professor H. T. Barnes, "The Mechanical Equivalent of Heat as Measured by Electrical Means."

Dr. Carl Barus, "Atmospheric Neuclei."

Dr. Louis A. Bauer, "The State of Our Knowledge Regarding the Earth's Magnetism."

Professor D. B. Brace, "Magneto-Optics."

Professor H. S. Carhart and G. W. Patterson, Jr., PhD. "The Absolute Value of the Electromotive Force of the Clark and Weston Cells."

Professor C. D. Child, "The Electric Arc."

Dr. K. E. Guthe, "Coherer Action."

Professor E. P. Lewis, "Electrical Discharges in Gases."

Professor L. T. More, "Electrostriction."

Professor E. F. Nichols, "The Unobtained Wave Lengths Between the Longest Thermal and the Shortest Electric Waves Yet Measured."

Professor E. L. Nichols, "Standards of Lights."

Harold Pender, PhD., "Magnetic Effect of Moving Charges."

Dr. M. I. Pupin, "Electrical Theory."

Dr. Edward B. Rosa, "Alternating Current Measurements."

Professor E. Rutherford, "Radioactive Change."

Professor J. C. McLennan, "Radioactivity of the Atmosphere."

Professor J. Trowbridge, "Electrical Discharge in Gases."

Professor A. G. Webster, "Electrical Theory."

Acceptances of membership in the Congress number over 1300 up to the present time, and in all 150 papers have been promised.

The following societies have all promised to hold conventions at St. Louis during the Congress week, and to hold conventions with one or more sections of the Congress: The American Institute of Electrical Engineers, The American Physical Society, The American Electro-Chemical Society, The American Electro-Therapeutic Association, The International Association of Municipal Electricians. The British Institution of Electrical Engineers has also arranged to co-operate under some plan, the details of which have not yet been determined.

The following bodies have promised to co-operate by sending delegates: The Société des Électricians, The National Electric Light Association, The Association of Edison Illuminating Companies. In addition similar co-operation is expected from various other societies.

## SUMMER SCHOOL FOR ARTISANS.

THE fourth annual session of the Summer School for Artisans, held under the direction of the College of Engineering of the University of Wisconsin, begins June 27, 1904, and continues for a period of six weeks. Courses of study are offered in the following subjects:

1. Steam, Gas and Other Heat Engines—Lectures on the theory of heat, the operation and methods of testing steam, gas and air engines, boilers, compressed air and refrigerating plants.

2. Applied Electricity—Theory of direct and alternating current dynamos and motors, the operation and methods of testing electrical machinery, batteries, transformers and other apparatus, photometry, and calibration of instruments.

3. Mechanical Drawing and Machine Design—Elements of applied mathematics, courses in mechanical drawing and machine design adapted to the preparation of the students.

4. Materials of Construction, Fuels and Lubricants—Lectures on the properties of materials, accompanied by laboratory tests; lectures on fuels and lubricants, with laboratory tests on the heating value of coals and efficiency of lubricants.

5. Shop Work—Practice with hand tools, wood and metal working machinery, and in blacksmithing and pattern making.

The iustructional force is taken from the regular faculty of the College of Engineering and the entire laboratory and shop equipment belonging to the college is used by the students in the summer school.

The requirements for admission do not extend beyond a working knowledge of English and arithmetic; but the policy is to allow a large amount of individual work so that the student may take advantage of all the preparation he has obtained.

As the demand renders it necessary, advanced courses will be established in the various subjects.

This school offers to those unable to take a regular four years' course an opportunity of obtaining practical working knowledge of the methods of testing and the use of instruments, together with such theoretical principles in each case as the nature of the snbject and preparation of the student may permit.

A bulletin describing the work of the School for Artisans in detail will be sent on application to Frederick E. Turneaure, Dean College of Engineering, Madison, Wis.

## HOW THE WAR NEWS COMES.

IT is probable that the principal feature of electrical interest which center in the inauguration of the Russo-Japanese war lies in the important part which the recently completed and all-American Pacific cable takes in the transmission of intelligence between the Far East and Anglo-Saxon communities, not to speak of countries of the continent of Europe, although they, too, now receive nearly all war news through the medium of the Pacific cable. The new connections thus afforded have enabled San Francisco to supplant London as the receiving center for news from the Orient, a change that was effected, to be exact, on March 12th of the present year.

The technical interest in the new situation lies principally in the distances covered by the new route, as compared with those of the old ones. Formerly all war news from Japan, China and Corea was telegraphed by way of India, the Mediterranean Sea, Europe and the English Channel to London, whence it was transmitted across the Atlantic to New York, whence it was re-wired to all points in America. These connections aggregated a distance of 15,000 miles to San Francisco, but now that city, as well as practically the remainder of the world, receives its war news through a succession of submarine cables of a length of more than 11,600 miles from Corea to San Francisco. Tien-tsin, on the coast of China, ninety miles from Peking, is practically the sending end of the Pacific cable system, with San Francisco as the receiving end, and the distance between them is traversed in eight stretches, as follows:

| From— | Miles. |
|---|---|
| Tien-tsin to Cheefoo | 280 |
| Cheefoo to Shanghai | 800 |
| Shanghai to Hongkong | 1,025 |
| Hongkong to Manila | 915 |
| Manila to Guam | 1,950 |
| Guam to Midway | 2,860 |
| Midway to Honolulu | 1,375 |
| Honolulu to San Francisco | 2,400 |
| Total | 11,605 |

## GOVERNMENT IRRIGATION PROJECTS.

WORK will be begun within sixty days on the Tonto Basin dam and reservoir. A payment of $40,000 has been agreed upon to satisfy holders of a prior claim on the dam site. Practically all holdings of settlers within the reservoir site have been purchased or bonded. The Tonto Basin and Salt River Valley wagon road, for which Congress has permitted issuance of $100,000 bonds, will cost only about $75,000, according to the latest estimate. Municipal elections are to be ordered in the several towns affected to provide for their proportionate shares of the bond issue. Phœnix will vote on the issuance of $67,500, Tempe $4000, Mesa $3500, these amounts to be apportioned according to the assessment rolls of the several municipalities.

Everything has been settled at Washington affecting the legal situation. Arthur Powell Davis, engineer in charge of construction, is preparing to move his offices into new quarters in the postoffice building, secured under a three years' lease. A telegram has been received from B. A. Fowler, president of the Water

Users' Association, saying that the contract between the association and the Government had been approved and signed by the Secretary of the Interior.

Nearly all the surveys at the dam site have been completed, and with the approach of warmer weather the main party of engineers will be moved to the State of Washington, there to do preliminary work on an enterprise looking toward the diversion of the waters of the Columbia in the Great Bend region. The Gunnison project, in Colorado, involving the construction of a tunnel five miles in length, seems to have been held up by the apathy of the farmers who are to be benefited. The Truckee River diversion enterprise is the only other of the Geological Survey storage schemes under construction.

## WHY IS GAS ENGINEERING SIDE-TRACKED?

*To the Editor*—SIR: At the meeting of the Pacific Coast Gas Association, in July, 1901, I had occasion in my address as president to call attention to the fact that the profession of gas engineering was deserving of some recognition by the colleges of this country. My suggestion provoked considerable discussion, but no action was taken. I write this in view of the approaching meetings of the different gas associations, with the hope that some influential member will take it up and have it fully discussed upon the floor.

Nearly every branch of engineering is recognized by degrees conferred, and there seems to be no logical reason why the profession which embraces in its requirements nearly all of the others in mechanical lines should not have a distinction in the scientific world. I believe that if resolutions of the different gas associations of the United States are addressed to colleges conferring degrees, requesting that to the curriculum of these colleges be added a course in gas engineering, and a corresponding degree be conferred upon successful students in that line, they could, at least for the present, establish such a degree, and confer it upon the men in the profession who are today worthy of it. The recent very rapid strides made in the profession of gas engineering, not only in the manufacture, but in the distribution of gas, has called out the very best talent in the ranks, and has required as high a degree of scientific attainments as any other profession.

While I realize to a great extent that titles do not always carry worth, I am arguing for this matter entirely upon the ground of the recognition by the scientific world of the distinct and honorable profession of gas engineering and trust that this effort of mine will result in bringing about what I believe would be only justice. Yours truly,

JOHN A. BRITTON.

San Francisco, Cal., March 28, 1904.

## PERSONAL.

Mr. J. B. Grimwood has resigned the secretaryship of the Pacific Coast Gas Association.

Mr. O. A. Honnold, electrical superintendent of the Utah Power Company of Salt Lake City, is visiting the transmission systems of California.

Mr. E. Tappan Tannatt, formerly Lieutenant Second United States Volunteers, and now a civil and electrical engineer at Honolulu, H. I., was a recent visitor to San Francisco.

Mr. W. F. Hynes, who has long been connected with the sales department of the Wagner-Bullock Company, has retired therefrom and is located in Los Angeles, where he will engage in a general electrical engineering business.

Mr. George Scarfe, division superintendent of the Bay Counties Power Company, with headquarters at Nevada City, has resigned, to take effect on May 1st, and thereafter he will be connected with an engineering company having headquarters in San Francisco.

Mr. F. V. T. Lee has been appointed Pacific Coast manager of the Fort Wayne Electric Works, the duties of which he will administer in conjunction with those attending the managership of the Stanley Electric Manufacturing Company, at 31-33 New Montgomery Street, San Francisco.

Mr. F. M. Ray has resigned the assistant general managership of the California Gas and Electric Corporation, San Francisco, to take effect on April 30th, and will hereafter devote himself to his own personal interests, prominent among which is the principal ownership of the Brooks-Follis Electric Corporation.

Mr. Frederick G. Baum, formerly professor of electrical engineering at the Leland Stanford University, and more recently assistant general superintendent of the California Gas and Electric Corporation, has been appointed to the chief engineership and the general superintendency of that corporation, vice L. M. Hancock, resigned.

Mr. Edgar E. Stark, late electrical engineer for Messrs. Jno. Martin & Co., San Francisco, and who recently left for Dunedin, New Zeland, as erecting engineer for the transmission system now under construction in that city by the Waipori Falls Electric Power Company, has entered into a contract to remain with the company named for a period of three years as its supervising and constructing engineer.

Messrs. A. M. Hunt and E. H. Benjamin have retired from the association with Professor C. L. Cory, Wynn Meredith and W. H. Allen, known as the Engineering Offices, 331 Pine Street, San Francisco. Mr. Hunt will join the firm of Hunt, Mirk & Co., general contracting engineers, at 614 Mission Street, San Francisco, and Mr. Benjamin will continue to occupy room 6, 331 Pine Street. The remaining members of the Engineering Offices, and who have succeeded to their business, have formed the firm of Cory, Meredith & Allen, consulting and supervising engineers, and will hereafter be located in rooms 7 and 8, 331 Pine Street.

Mr. Arthur Warren, whose work in the field of technical journalism and whose success as what one may perhaps call a "publicity promoter" is too well known to every one in the industrial field to need dwelling upon, has entered the service of the Allis-Chalmers Company as manager of the department of publicity, with headquarters at Milwaukee, Wis.

Mr. Warren is a Bostonian with remarkable qualifications for the work to which he has of late devoted himself. Coming of a family of considerable mechanical aptitude and distinction, he prepared himself for the technical side of his work by actual machine shop practice. After this he began to travel, and while traveling wrote about things he saw. The transition to journalism was easy, and in 1883 Mr. Warren joined the staff of the *Boston Herald*, whence he continued successively in editorial work on the *Beacon* and the *Home Journal*, of Boston. In December, 1888, Mr. Warren was sent abroad by the *Boston Herald* as its London correspondent, in which capacity he served most efficiently for nine years, besides writing for a number of other American and British publications. His London home, which he still retains, was thus for many years a charming center of social and literary intercourse, in which many famous Americans and Europeans participated. In November, 1897, Mr. Warren returned to the United States at the invitation of Mr. George Westinghouse, a man quick to recognize the talent suited to carry out important new plans; and he immediately proceeded to organize the Westinghouse publishing department, whose record of solid achievement in the way of publicity of the best kind as to articles, pamphlets, advertising and the diplomatic aspects has certainly never been surpassed. In February of this year, his work in that connection, both in this country and in Europe, being practically completed along the original lines laid down, Mr. Warren resigned. He has been actively engaged since then on literary work of all kinds for the leading magazines and newspapers, and had planned to sail for Europe on March 12th, but he was invited by the executive of the Allis-Chalmers Company to become manager of publicity for that corporation under its new regime.

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VOLUME XIV MAY, 1904 NUMBER 5

# EDITORIAL.

**THE WIRELESS ERA.**

It was a long reach of time—nearly seven decades in fact—from the memorable year when the electrical transmission of physical movements over a conducting line made the telegraph a reality, to the end of the nineteenth century when the transmission of mechanical power over long lines in great quantities by means of electrical devices became a potent factor in contributing to civilization's supply of available motive power.

How long will it be before the truth of the claims shall become demonstrated that wireless telegraphy is destined to be the forerunner of wireless power transmission?

That wireless telegraphy has at last become a commercial success in certain directions is no longer to be doubted. Witness the situation on the Atlantic steamers, where the ships of the American, Red Star, French, Cunard and both of the German lines, as well as some of the transports, have been equipped with Marconi apparatus, so that beginning with May 15th they will each issue a daily newspaper while at sea that will contain the news of the world, served in as fresh and crisp a form as is presented in the morning paper at home. It is estimated that during the summer months from 20,000 to 30,000 passengers are afloat each day on the Atlantic, and most of these, at least, will be in a position to testify to the practicability of etheric telegraphy.

The detail of publication of this forthcoming oceanic daily newspaper is interesting. The telegraphic news which it will lay before its readers at the breakfast table will be supplied by the New York and London offices of the Associated Press, and also by Reuter's News Agency, which is to supply the Cunard liners exclusively. Marconi transmitting stations have been established at Canso, Nantucket and Babylon, on the American coast, and at Poldhu, England. All ships have been fully equipped with Marconi apparatus, and the scheme of operation is that the ships are in constant communication with each other, or with one or the other of the transmitting stations, during the entire voyage. It is therefore completely practicable to expand the present news service on ship board into as full a telegraphic report as a well managed newspaper will have ashore. Each ship, of course, is provided with type setting machines, a stereotyping plant, a good, quick press and the men to run them, as well as a complement of telegraph operators.

Some forty years after the invention of the telegraph came that of the telephone, and now that the principles of electrical science are known to an almost absolute exactness, the enlightenment of the day has made it possible for wireless telegraphy to be followed far more closely by wireless telephony. As yet, however, the latter has begun only modestly, but nevertheless the beginning has been sturdily made, and although its limitations are as yet circumscribed, it has shown its possibilities, and will develop.

Briefly described, the success thus far attained in wireless telephony has been due, first, to the use of the selenium cell, and, second, to the so-called speaking arc. The former resembles the coherer strongly in that it is a conductor of variable resistance, for while the resistance of the coherer is varied in an exceedingly wide degree by the washing of breakers from etheric waves, so to speak, that of the selenium cell is varied by the action of waves of different intensities of light. Bell was the first to transmit speech "along a ray of light" by the interposition of a selenium cell and a battery in circuit with a telephone receiver, when a ray of light reflected from a diaphragm that was being spoken into would cause the voice to be reproduced in the receiver. Communication over distances as high as several hundred yards was thus reached. The next development occurred in 1898, when Simon noted the phenomenon of the speaking arc, wherein a direct current arc will reproduce sounds and the voice, provided the arc circuit be traversed simultaneously by even the feeble induced currents from a telephone transmitter. Simon's replacement of the Bell receiver by the speaking arc effected a material improvement in the art, and when, comparatively recently, Ruhmer used an improved selenium cell in conjunction with a perfectly constructed silvered projector, the transmission of speech became possible over a distance of about twenty miles. This was accomplished in Germany last summer, when the *Nymphe* engaged in conversation with the shore across the distance named.

Perhaps this would better be called optical telephony —but it is wireless, nevertheless.

The transmission of power in large amounts by wireless devices now seems to be as far removed from actual

realization as was the movement of the telegraph armature at Washington from Baltimore, in 1837, from the first achievement of long distance power transmission at Frankfort from Lauffen, in 1891. More than half a century was required to bring the art of transmission up from a simple mechanical movement of exceedingly low moment to the delivery of mechanical power of commercial avail, but then as the knowledge of today compares with that of yore, so may progress be expected, and surprise need not be expressed should the next decade or two bring about a sign of promise. But at present the wireless transmission of power in large bulk appears to be as remote from practical accomplishment than is the commercial navigation of the air.

No one has given more research into etheric power transmission than Tesla—the man who, above any other one in America has made high tension long distance transmission commercially feasible in its perfect sense through the development of the induction motor. Tesla points out* that the progress which he has made in the transmission of electrical energy without wires, though necessarily slow, has been both steady and sure, so that much has already been done toward making his system commercially available in the transmission of energy in small amounts for specific purposes as well as on an industrial scale. In its present state of development, the system involves the employment of a number of plants, "all of which are capable of transmitting individualized signals to the uttermost confines of the earth," and "since a single plant of but 100 horsepower can operate hundreds of millions of instruments, the system will have a virtually infinite working capacity." The experimental results attained in 1899 have already been published,† but of the present status of the system naught is known beyond Tesla's assurance that "the first of these central plants would have been already completed had it not been for unforseen delays which, fortunately, have nothing to do with their purely technical features. The best design of which I know has been adopted, and the transmitter will emit a wave complex of a total maximum activity of 10,000,000 horsepower, 1 per cent. of which is amply sufficient to girdle the globe. This enormous ratio of energy delivery is obtainable only by the use of certain artifices which I shall make known in due course."

The experiments thus far outlined savor very strongly of wireless telegraphy on a world-wide scale, but meanwhile the transmission of energy on an industrial scale through wireless means has not been neglected, for the Canadian Niagara Power Company proposes to install a Tesla wireless transmission plant for the distribution of 10,000 horsepower under a tension of 100,000,000 volts. "This energy," says Tesla, "will be collected all over the globe, preferably in small amounts ranging from a fraction of one horsepower to a few horsepower. One of its chief uses will be the illumination of isolated homes. It takes very little power to light a dwelling with vacuum tubes operated by high frequency currents, and in each instance a terminal a little above the roof will be sufficient. Another valuable application will be the driving of clocks and other such apparatus, and in fact there are innumerable devices of all kinds which are now employed or can be supplied, and by operating them in this manner I may be able to offer a great convenience to the whole world with a plant of no more than ten thousand horsepower."

Here, then, is an expression from the most competent —not to say the most sanguine—source upon the present realizations and future hopes of wireless power transmission advocates. Tesla is not generally believed to be a day-dreamer—he is an originator, and his mind has worn a well beaten path, the actual course of which, lies in a new and previously all-but-unexplored domain of science. But granting all he claims, wireless power transmission is as yet but the new born infant, the manhood of which must be carefully and patiently reared before its eventual potentialities may become manifested. In the meantime, vested transmission interests will experience no alarm, for it is not to be given to this generation, nor perhaps the next, to witness the industrial revolution which the transmission of power through ether may possibly bring about in years to come.

*Electrical World and Engineer*, Volume XLIII, page 429, *et seq.*, March 5, 1904.

†*The Century Magazine*, June. 1900

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**PROGRESS TO BE THE WATCHWORD.**

As these forms go to press, definite action has not been taken in fixing the meeting place of the Eighth Annual Convention of the Pacific Coast Electric Transmission Association; but it is probable, nevertheless, that it will be held in Monterey, the date being June 21st and 22nd. Due notice will, however, be issued before May 15th, and the plans thus far matured give abundant warrant for the assurance that the meeting will be one of the most successful and entertaining yet held. A number of invaluable papers have been secured upon timely subjects; but beyond these the proposed reorganization of the Association along lines that will broaden its scope, increase its membership, and enhance its usefulness, will affect the well being of every branch of the electrical industry on the coast, as well as of the vast commercial interests which are related to it in any sense.

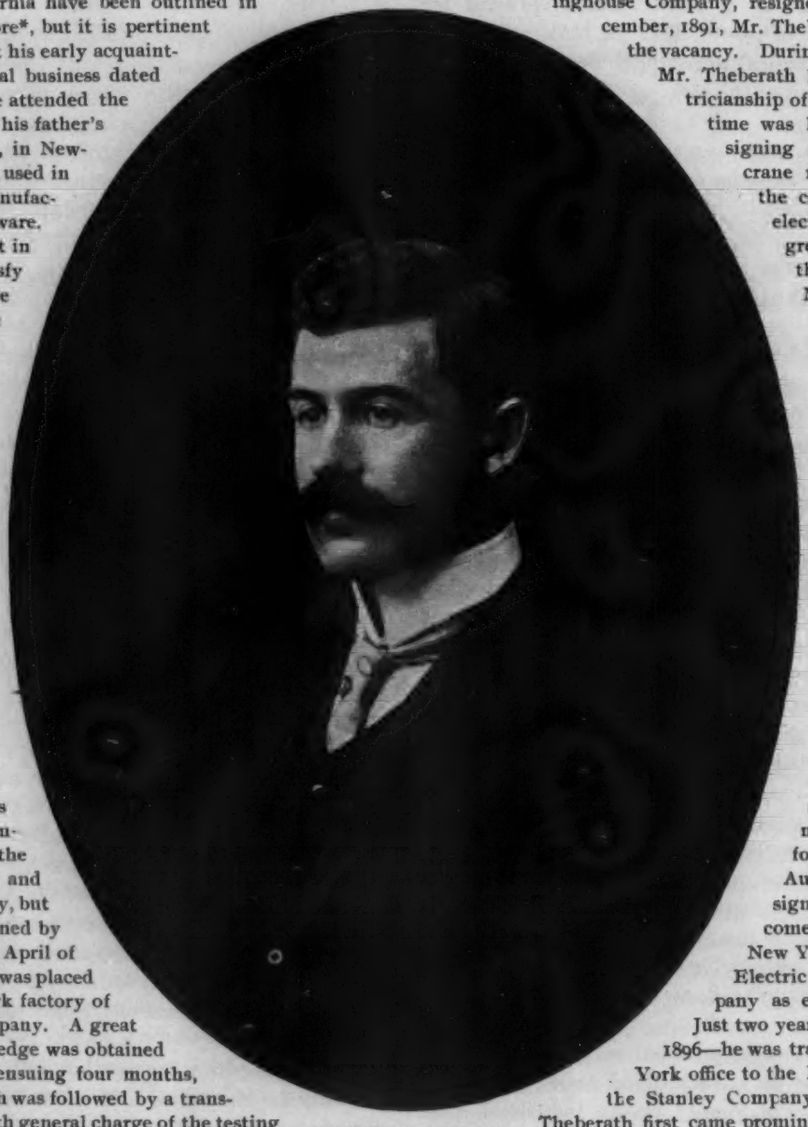
The forthcoming convention will, then, be noteworthy not only for the value of its contributions to engineering knowledge, but also for the fact that it will inaugurate a new era in engineering fraternization on the Pacific Coast. The bars which have kept the general trade from participation in the councils of the Association will undoubtedly be let down, membership will, in all probability, become individual rather than corporate, and the whole electric lighting and power industry, together with those manufacturing representatives who cater to it, will in all likelihood join into a common fellowship for the general engineering good of all.

## OBITUARY.

Mr. Theodore E. Theberath, a native of New Jersey and forty years of age, died in San Francisco on March 29th last from the indirect effects of an injury suffered to his kidneys by falling on a sleet-covered stone stairway while in the East several years ago. In his all too premature death the transmission industry of the country has suffered an irretrievable loss, and the grief of his friends can find consolation only in the knowledge that he has left a monument of engineering ability which will be enduring.

The early career of Mr. Theberath and his rise in the transmission industry in California have been outlined in these columns heretofore*, but it is pertinent to state at present that his early acquaintance with the electrical business dated from the time when he attended the electro-plating baths in his father's factory which produced, in Newark, the various articles used in connection with the manufacture of saddlery hardware. Several years were spent in this factory, and to satisfy the desire for knowledge which had become the characteristic of the young man, he was sent to Stephens Institute of Technology, whence he graduated with the degree of Mechanical Engineer in June, 1888. Six months were then spent in experimental mechanics at Stephens Institute, after which Mr. Theberath entered the service of the United States Electric Lighting Company as detail draftsman. On February 1, 1889, the United States Electric Lighting Company was absorbed by the Westinghouse Electric and Manufacturing Company, but his services were retained by the new owners until April of the same year, when he was placed in charge of the Newark factory of the Westinghouse Company. A great deal of practical knowledge was obtained in this position in the ensuing four months, the expiration of which was followed by a transfer to the laboratory with general charge of the testing department and all special work of the outside construction department. Some of the work coming under the head of "special" was the installation, in June, 1890, of the first two large generators for the Pittsburg Reduction Company, of Pittsburg, for the reduction of aluminum. This installation consisted of two generators, each having a capacity of 2500 amperes at sixty volts, and, being run in multiple, they delivered a current of 5000 amperes. This was the beginning of the great plant now operated at Niagara Falls by the Pittsburg Reduction Company for the reduction of aluminum.

*THE JOURNAL, Volume VI, page 56, September, 1898.



THEODORE E. THEBERATH

In February, 1890, Mr. Theberath was engaged in the installation of several Westinghouse plants to operate coal cutting machinery in the soft coal mines in West Virginia. In August, 1891, he commenced the installation, which he completed within a few months, of the electrical apparatus for the concentration of magnetic iron ore at the mill of the New Jersey Magnetic Concentrating Company, located in the Adirondack Mountains, in New York State. This work, in connection with the wide range of experimental work constantly under way at the laboratory, resulted in Mr. Theberath becoming possessed of information and experience of unusual value along technical lines, so that when Jno. F. Kelly, who was then chief electrician of the Newark branch of the Westinghouse Company, resigned that position in December, 1891, Mr. Theberath was appointed to the vacancy. During the nine months that Mr. Theberath held the chief electricianship of theNewark branch, his time was largely occupied in designing special generators and crane motors. Believing that the commercial side of the electrical industry extended greater advantages than the engineering side, Mr. Theberath resigned from the chief electricianship of the Newark branch of the Westinghouse Company on October 1, 1892, and immediately entered the employ of the Ansonia Electric Company, of Chicago, as special sales agent for Stanley transformers. On the dissolution of the Ansonia Electric Company, in October, 1893, he entered the service of the Weston Electrical Instrument Company in charge of the standardizing department, where he remained for nearly a year. On August 1, 1894, he resigned this position to become associated with the New York office of the Stanley Electric Manufacturing Company as engineer and salesman. Just two years thereafter—August 1, 1896—he was transferred from the New York office to the Pacific Coast agency of the Stanley Company at San Francisco. Mr. Theberath first came prominently before the electric transmission interests of the Pacific Coast through the position which he next held as electrical engineer for Messrs. Jno. Martin & Co., Western representatives of the Stanley Electric Manufacturing Company and other well known concerns. His initial work in this capacity was in the construction of the transmission plant of the Blue Lakes Water Company, through the means of which some 1500 horsepower was distributed to the towns and mines along the Mother Lode in Amador and Calaveras counties.

Shortly after, and upon the inception of the Yuba Power Company's transmission system from Brown Valley to Marysville,

Mr. Theberath became identified with the Yuba Company as constructing engineer, and since the beginning of this installation, which has proved to be one of the two direct forerunners of the great transmission system of the California Gas and Electric Corporation, popularly known as the Bay Counties System, Mr. Theberath has remained in the service of the various companies that have been led up to the present corporation, until the time of his death.

He was the engineer of the original plant at Colgate, known as Colgate Power House No. 1, and which embraces practically one-half of the generating station bearing that name. Subsequently many months were spent by him in the exploration of water rights that were geographically located so as to be tributary to the Bay Counties development, and while engaged in this work he was largely, if not preponderatingly, instrumental in deciding upon the location of the Nimshew plant as well as of the French Creek plant. Of these great stations the former has been placed in service, and although not as yet fully completed, it will during the spring be delivering some 12,000 horsepower into the transmission lines of the system. With the opening of the spring active work will be again resumed in the building of the French Creek plant, which will swell the generating capacity of the system by a further 22,000 horsepower. Thus, with the 18,000 horsepower that is being delivered from Colgate, a total exceeding 50,000 horsepower in present and immediately prospective hydro-electric power development of the great Bay Counties system is to be accredited to his location and engineering paternity. Where, in all the West, is there a man whose record of actual achievement in transmission engineering can equal or even approach this? And for answer—there is none.

Though not a prolific writer, Mr. Theberath has contributed valuable papers to the Pacific Coast Transmission Association, and in its conventions he was always an active participant in the discussions which form such an invaluable part of its transactions. When stricken with his last illness he was engaged in writing a paper for the American Institute of Electrical Engineers which would have given the concentration of his large experience in the building and operation of long-distance, high-tension pole lines in California. He was elected an associate member of the American Institute of Electrical Engineers on March 23, 1898, and was transferred to full membership on June 24th of the same year. He was buried on April 1st with Masonic honors at Cypress Lawn, and his funeral was marked by the attendance of those who are most prominent in the transmission industry in California, all of whom shared the deep grief so nobly borne by his stricken widow.

Physically Mr. Theberath was endowed magnificently, and his deep love for "my mountains," as he reverentially termed them, bespoke his passion for the wilds. Personally no man who was blest with his acquaintance could speak otherwise of him than in words of highest esteem. Broad in experience, he was equally generous in bestowing the fruits of it. Kind and sympathetic, from him, when all others failed, would ever spring that beneficent fountain of sincerity which gives lasting cheer and consolation. He was, indeed, as fine gold—as a priceless treasure which, when lost, is irreplaceable.

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# INDUSTRIAL

## THE WESTINGHOUSE TYPE D OIL SWITCH.

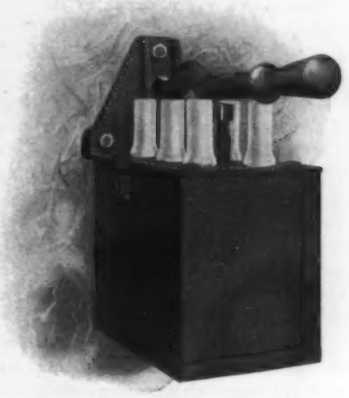
OIL as an insulating and arc suppressing medium in high tension current interruption devices used where space is a factor has a value that is universally known, and the equipment of the modern central station usually contains evidence of the general approval of apparatus of this kind. Its reliability, the small amount of attention required to keep it in order, its compactness and consequent ease of installation, give such apparatus an especial adaptability for use in many locations.

The Westinghouse Type D oil switch is a comparatively new addition to the line of oil immersed circuit breaking apparatus, for in a number of important particulars it has original features which have no counterpart. It is made with two, three and four poles, single and double throw, in all capacities up to and including 1000 amperes and 3300 volts. The ultimate breaking capacity is given at 600 kilowatts for single-phase, 1200 kilowatts for two-phase and 1000 kilowatts for three-phase currents.

A style made for wall mounting is of the form which is herewith illustrated. When used upon a switchboord, the switch is mounted upon the back of the panel, the handle projecting through the front. The visible portions are finished in copper and dull black in pleasing harmony, and forming an effective contrast with the marble panel. As regularly made, the switch is designed for use upon marble two inches thick, but by substituting shorter bolts it can be as easily mounted upon panels of lesser thickness. The handle of the double throw switch is locked when the switch is open. Pressing upon a button in the end of the handle releases it and the circuit is closed by a pressure either up or down, the directions in which it is the easiest to apply force, and which cause the least strain upon the panel.

This is one of the smallest oil switches made, and its size, compact form, ease of making connections thorough insulation of connections when made, and facility with which the interior can be inspected give it a superior adaptability for use under the various conditions applying to such installations.

The mechanism is notable for its simplicity and efficiency. The design provides for the fewest possible number of links in the operating device. The switch is of the knife blade or jaw type, giving a maximum amount of contact with a low temperature rise, which will not exceed 20 degrees with a normal current. The final arc is taken upon an arcing tip, which is renewable. By this provision no damage is done to the main contacts, and the life of the switch is prolongee indefinitely.



WESTINGHOUSE TYPE D OIL SWITCH

Surface and leakage distances have been carefully worked out and will be found to be ample. Contacts are thoroughly insulated. They are mounted upon a wooden base suspended from the iron supporting frame, and are at all times immersed in the oil.

Each pole is isolated by a barrier of wood which has been subjected to a treatment to give it high insulating qualities, and any possibility of communication of an arc between poles is thus avoided. The leads are brought out at the top, connections to the circuit being made inside the switch, and a porcelain insulator slipped over the joint. By this means all conductors are kept outside the oil tank.

The tank is of sheet metal, having a suitable insulating lining, and is attached to the case by bolts. The lugs through which the bolts pass are slotted, and when the nuts are loosened the bolts can be lifted out sidewise, thus facilitating removal of the tank.

The form of the tank, and the interposition of the wooden barriers between the poles, appreciably reduce both the amount of oil required and the danger of ignition during a fire. The "Kilarc" oil used is especially compounded for insulating purposes, and has a fire test of 400 degrees Fahrenheit. Its freedom from acidity and volatile matter give it high insulating properties and make the evaporation low, while its viscosity renders it effective for extinguishing the arc. A sufficient quantity for refilling is furnished with each switch.

## INDUSTRIAL

### GRAPHITE AS A LUBRICANT.

THE three reasons for lubrication are in the following order of importance: First, to prevent over heating, sizeing and cutting of the parts; second, to reduce wear as far as possible; and third, to lessen the amount of the power wasted.

Good lubrication depends as much upon the condition of the surfaces as upon the quality of the lubricant itself, and the smoother a bearing surface can be made the easier it is to lubricate. This point is strongly emphasized when pure flake graphite is used as a lubricant. It is extremely soft, and, when pure, entirely free from grit, and when introduced between friction surfaces it soon rubs into the metal, filling every pore and crack and irregularity of metals, coating them with a veneer of great hardness, endurance and of exceeding smoothness. This greatly reduces the necessity for using as heavy an oil as before to keep the surfaces apart, and therefore effects a marked reduction in both solid and liquid friction.

Graphite is found in various parts of the world, and occurs in nature in both crystalline and amorphous forms more or less closely associated with silicates or other earthy impurities. The thin flake form, such as is taken from the Dixon mines in Ticonderoga, N. Y., occurs much purer than the amorphous forms, but even this requires elaborate processes of milling before it is wholly free from grit and fit for lubrication purposes. If graphite is not absolutely pure it is unfit for purposes of lubrication, but these impurities may exist although they are almost impossible to detect by the touch. The only guarantee that the user of graphite can have is to buy his supplies in the original packages of a responsible manufacturer. Lubricating graphite should also have the flake or crystalline form, first because the flake graphite has a greater tenacity for metal surfaces and because it is much purer than the amorphous form.

For many years graphite has been used extensively as an emergency preparation to be applied to pins and bearings when they showed signs of excessive heating, but today the up-to-date engineer has a can of graphite in his engine room and uses it occasionally on almost all his bearings and in his cylinders to get the benefit of its wonderful properties for smoothing metal surfaces.

Cylinders in which graphite has been used take on a wonderful mirror-like polish and valves work quietly and without straining or cutting. Bearings on which graphite is used never over heat, and it is a fact beyond all question that abrasion and cutting of friction surfaces absolutely cannot take place in the presence of graphite. Therefore when it is used regularly in the engine room there will never be any of the costly and perhaps disastrous results of over heated bearings.

Thinner, cheaper oils will suffice for work that formerly required the use of expensive heavy bodied oils, and friction may be lowered at every point with corresponding benefit to the coal pile.

Graphite has the peculiar property of being unaffected by any possible degree of heat attainable in the cylinder, and therefore offers a ready means of lubricating gas engine cylinders or steam engines using superheated steam, thus simplifying this difficult problem.

Graphite lubrication has long since passed the experimental stage, and thousands of engineers are using it in their cylinders and on their bearings with regularity, and find that its use is an absolute guarantee against friction troubles.

The Joseph Dixon Crucible Company, of Jersey City, N. J., were the parents, as it were, of the graphite industry. Having been engaged in the manufacture of various products for the past seventy-six years, their goods are known to be pure throughout the civilized world. Any question about the use of graphite alone or in combination with oils or greases for any purposes will be answered by the Joseph Dixon Crucible Company to the best of their long experience.

### SOME TURBINES IN THE BOSTON NAVY YARD.

AN interesting departure in engineering practice by the authorities of the United States Navy, Department of Yards and Docks, is marked by the introduction of Westinghouse-Parsons steam turbines for furnishing power for lighting the buildings and yards, and power for operating dry dock pumps and miscellaneous machinery.

The initial installation of this character is in process of construction at the Charleston Navy Yard, Boston, Mass., and for the present one Westinghouse-Parsons turbine generating unit of 750 kilowatts capacity will be placed in service. This turbine will be of the new short-barreled type, and is now under construction at Pittsburg. A Worthington surface condenser will be employed, using salt water for circulation, the condensers being located between the foundation, which consist of concrete piers. A running vacuum of twenty-eight inches will be secured through the aid of a dry eir pump. Steam will be furnished at 150 pounds pressure by Babcock & Wilcox boilers in units of 350 horsepower.

The present power plant is the outcome of an appropriation made in 1898 by Congress for a dry dock and pumping plant to be located at the Charlestown Navy Yard, the new plans for a dry dock equipment providing for a power plant located near the outer end of the dock, with piping connections to both the old and the new docks, so that one pumping plant would be able to handle them simultaneously or separately. During the period of construction of the new dock the Department of Yards and Docks at this navy yard underwent considerable enlargement, necessitating an immediate increase in electrical generating equipment for supplying light and power to buildings and departments. In view of this situation, it was decided to supersede the dock pumping plant originally provided for by a central lighting, power and heating plant for the entire department, although retaining the dry dock pumping equipment, which will now be electrically driven from the central station. It is also intended to supply from this plant, electric light and power to the vessels docking which do not happen to be under steam. The power system as now under construction is, therefore, considerably more comprehensive than originally laid out. The turbine plant will supply three-phase alternating current at 2300 volts, this voltage being used for general distribution and for direct use in larger motors, while for lighting lower voltage will be provided by transformatioh. The turbine generator will be served by a thirty-seven and one-half-kilowatt Westinghouse compound exciter unit.

### AN ECHO FROM THE BALTIMORE FIRE.

THERE is a boy in Baltimore who thinks that the recent fire in that city was not such a bad thing after all. While "snooping" among the ruins he came across what the fire had left of a small Crocker-Wheeler motor. He gathered up the castings and wrote a letter to the manufacturers describing his find and closing thus: "Can I wind the armature so as to use it as a direct-current, series-wound dynamo? If so, what size and how much wire must I use on the field magnet and armature? How many coils must I divide the armature into? Thanking you very much for the information you can give me," etc.

Many a collector of sovenirs has carried things away from the scene of the fire, to be placed in curio cabinets and on rural mantel shelves, but this young Franklin knows a trick worth two of that.

## THE LAY PRESS.

### Reflections of Popular Opinion Bearing Upon the Financial and Engineering Interests of Quasi-Public Corporations.

#### AN ELECTRIC RAILROAD TO TAHOE.

Reno and Lake Tahoe are to be joined by an electric railway. The survey follows the course of the Truckee River along a territory as picturesque as any in either California or Nevada, lying between the wooded slopes of the Washoe Range and of the majestic snow-capped peaks of the Sierras. Construction begins at Reno this week. The enterprise is backed by H. E. Huntington and other Californians associated with him in other electric railways operated in the State. The object of its construction is to enter into competition for the valuable summer traffic to Lake Tahoe, which is now monopolized almost exclusively by the Southern Pacific and Truckee-Tahoe Railroad. The latter traverses the least picturesque section of the beautiful valley of the Truckee, all of which the electric railway will embrace. By making Reno the northern terminal of the new line, its promoters doubtless expect to intercept west-bound tourists from the Eastern States at that point and induce them to take the electric route to Tahoe before completing their journey across the Sierra. For the encouragement of this traffic arrangements will probably be made with Eastern lines for the issuance of through tickets with stop-over privileges at Reno. Then, again, the latter city is conveniently located to the Western Pacific Railroad survey crossing the Sierra Range at Beckwith Pass, which is only thirty miles distant.

The new enterprise seems to be a link also in the Huntington plan of paralleling the steam railroads of the Southern Pacific Company from one end of the State to the other. He already controls the electric railways in the southern counties, is developing a great electric-power plant on Kern River, and owns the Fresno electric railway system and that at Stockton. Last year a preliminary survey was made for an electric railroad from Placerville across the summitt of the Sierra to Truckee and Tahoe, which was found to be quite feasible. The latter may be constructed to join the Reno line and perform the same function on the western side of the Sierra as the Reno road will perform on the eastern slope. The Placerville-Tahoe electric road, when built, will be a formidable rival to the Southern Pacific Company, as the view from its cars through the most attractive part of the Sierra will not be obstructed by snowsheds, which now shut out the most romantic part of the trip on the Central Pacific. In time, probably, these isolated sections between the southern counties and Reno will be joined, making it possible for tourists to enjoy a continuous electric railroad ride from one end of the State to the other.—*San Francisco Chronicle, April 24, 1904.*

#### STREET RAILROADS AND THE PUBLIC.

The public seems to be taking the street-railroad situation in a philosophic spirit, hoping and believing that no strike will occur to interrupt business, but quietly planning for other means of getting back and forth should circumstances require it. There is some little speculation as to the legal questions involved and legal risks to be encountered by all concerned, as to which the facts seem to be somewhat as follows: The present owners of most of the street railroad lines are Eastern men, reputed to be experts in the management of such properties. The capitalization, however watery, is strictly within what is permitted by law, and the companies are entitled to pay dividends and interest on all of it if they can get it out of fares not exceeding 5 cents for each fare on each line for which a franchise exists. By the system of transfers in force they are doing much better than that, as we all know, and doubtless make money in so doing. Some of the franchises require cars to be run every fifteen minutes during the day, "unless prevented by riot or unavoidable cause," and some are silent on the subject. The companies have the right to look to the city for perfect protection of their employes from assault or riotous or abusive interference with the performance of their duties, and if the city fails to give it no cars at all need be run. If damage is done to property as the result of riots the city will be presumably liable for it. The franchise is a contract between the corporations and the people of the city, and each side has the legal right to hold the other strictly to the agreement.

In regard to agency, the city has the right to select such persons as it desires to administer its laws and the companies have the right to employ such persons as they please to perform the service which they have guaranteed. If either fail in their duty the corporations and the people are responsible respectively. In case of a strike, if perfect security and peace is preserved and assured, the companies will be compelled to operate cars every fifteen minutes over such parts of their lines as have been guaranteed that service, no matter what it may cost them or what conditions they may have to agree to. If they do not, they will presumably forfeit their franchises. If, however, riotous conditions exist, they may keep their cars in the barns. Riotous conditions would doubtless be construed to exist if the streets were lined with hoodlums yelling "scab," even if no actual assaults were made. There would be reasonable fear of them. If riotous conditions were continued for a long time, so as to prevent running the cars and earning income, the companies might default on the interest on their bonds. In that case the bondholders might, and presumably would, apply to the United States courts for a receiver, who would then, under the orders of the court, proceed to operate the system by the aid of United States troops if necessary. If, as a result of neglect of the city, the stock was thus wiped out, we do not know whether the city would be liable to the stockholders or not, but we have no doubt whatever that they would try to collect it, and that title to property in the city would long be clouded by a suit for many millions.

The above is what we suppose to be the law of the case. If we are correct, the only chance to win which the carmen would have, in case of a strike, would be to promote perfect peace and let the companies run their cars every fifteen minutes, if they can. If riots start the carmen's cause would be irretrievably lost. —*San Francisco Chronicle, April 28, 1904.*

## COMMUNICATION.

REDDING, CAL.—George L. Carr is interested in the proposed construction of a telephone line from Delta to Carrville.

DAWSON, ALASKA—It is reported that Captain Fuller, of the Dawson Telephone Company, will put in a line to Fairbanks.

SANTA PAULA, CAL.—The Home Telephone Company, of Los Angeles, has applied for a franchise for a telephone system here.

LATAH, WASH.—Citizens of Rock Creek, near this place, are to put in a rural telephone line running from Rock Creek to Latah.

SILVER CREEK, WASH.—E. T. Hunting, manager of the Home Telephone Company, is preparing to connect his line with Chehalis.

FERNDALE, WASH.—The Canadian Bell Telephone Company is preparing to put in a line between Ferndale and Victoria, B. C., via the San Juan Islands.

SANTA ANA, CAL.—Sealed bids will be received by E. Tedford, city clerk, until May 2nd, for the installation of an electric fire alarm system in this city.

EUREKA, CAL.—R. W. Gray, division construction foreman of the Sunset Telephone and Telegraph Company, has arrived here for the purpose of laying an underground conduit for the company's cables.

NEVADA CITY, CAL.—E. German, of North San Juan, and Frank Hall, owner of the Brophy Mine, are arranging to construct a private telephone line about two miles in length to be connected with the Sunset Company's lines.

PETALUMA, CAL.—The Two Rock Valley Rural Telephone Company has been organized at Two Rocks, near here, for the purpose of putting in a rural telephone line twenty-five miles in length. George Gaston is secretary of the company.

## FINANCIAL.

SAN FRANCISCO—A comparative statement of the earnings of the California Gas and Electric Corporation for March, 1903, and March, 1904, shows the following:

| | 1904. | 1903. | Increase. |
|---|---|---|---|
| Gross earnings | $329,247.03 | $213,272.51 | $115,974.52 |
| Operating, maintenance, taxes, insurance and bond interest of subsidiary companies | 237,255.16 | 156,907.58 | 80,347.58 |
| Surplus | 91,991.87 | 56,364.93 | 35,626.94 |
| Corporation bonded indebtedness | 36,458.33 | 28,743.99 | 7,714.34 |
| Balance | 55,533.54 | 27,620.94 | 27,912.60 |
| Sinking fund | 12,500.00 | 12,500.00 | ..... |
| Net | 43,033.54 | 15,120.94 | 27,912.60 |

SAN FRANCISCO—Following is the statement of the condition of the San Francisco Gas and Electric Company for the year ending December 31, 1903:

| | 1903. | 1902. | Increase. |
|---|---|---|---|
| Total income | $2,504,771 | $1,989,834 | $514,937 |
| Operating expenses | 1,534,814 | 1,285,897 | 248,917 |
| Net | $969,957 | $703,937 | $266,020 |
| Depreciation, etc., funds | 395,000 | 282,101 | 112,899 |
| Balance | $574,957 | $421,836 | $153,121 |
| Dividends | 396,211 | ..... | ..... |
| Surplus | $178,746 | ..... | ..... |

Net profits and consumers for the last four years follow:

| | 1903. | 1902. | 1001. | 1900. |
|---|---|---|---|---|
| Net profits | $969,957 | $703,937 | $458,440 | $675,556 |
| Consumers December 31st: | | | | |
| Gas | 65,710 | 35,791 | 34,271 | 30,809 |
| Electricity | 9,771 | 5,238 | 4,286 | 2,325 |

## ILLUMINATION.

MONROE, WASH.—The Monroe Water and Light Company will install an electric light plant here.

SAN DIEGO, CAL.—The San Diego Gas and Electric Company will extend its system to National City.

RENO, NEV.—The Nevada Power, Light and Water Company will extend its lighting service to East Reno and will improve its city system.

SALT LAKE, UTAH—The owners of the D. F. Walker Block will install their own electric light and heating plant, at a cost of about $20,000.

LOGAN, UTAH—Garff & Son have submitted a proposition to the town council for putting in a light and power plant. The matter is now in charge of a committee with Mayor Morris as chairman.

VANCOUVER, WASH.—The Department of the Columbia, United States Army, will install electric lights at the post here. The Vancouver Electric Light Company anticipates receiving the contract and is arranging for additional machinery.

SAN FRANCISCO—At the annual meeting of the San Francisco Gas and Electric Company, held on April 28th, the following officers and directors were elected for the ensuing year: W. B. Bourn, president; A. H. Payson, first vice-president; C. Osgood Hooker, second vice-president; C. L. Barrett, secretary and treasurer; directors—Antone Borel, Henry E. Bothin, W. J. Dutton, I. W. Hellman, Homer S. King, Edward J. McCuthen, C. O. G. Miller, Louis F. Monteagle, Daniel T. Murphy, Robert Watt and the president and two vice-presidents named above.

## NEW INCORPORATIONS.

EXPRESS TELEPHONE AND TELEGRAPH COMPANY—Incorporated at Durkee, Baker County, Or., by W. G. Ayre, F. S. Bubb and F. L. Moore, with a capital stock of $1500.

ALTURAS ELECTRIC LIGHT AND POWER COMPANY—Incorporated at Alturas, Cal., by D. E. Mulkey, Sarah M. Mulkey, Delia E. Mulkey, I. W. Gibbons and Julia M. Gibbons, with a capital stock of $20,000, fully subscribed.

IONE AND EASTERN RAILROAD COMPANY—Incorporated at San Francisco by J. Dennis, W. Dennis, J. J. Fagan, W. Pardy and others, with a capital stock of $1,000,000. The company will construct an electric railroad fourteen miles long.

CENTURY ELECTRIC CORPORATION OF SAN FRANCISCO—Incorporated at San Francisco, Cal., by Frank M. Greenwood, C. M. Wood, E. F. Weihe, L. D. Hitzeroth and H. S. Tittle, with a capitalstock of $250,000, of which $5 has been subscribed.

MCCARTY WIRELESS TELPEHONE COMPANY—Capital stock $1,000,000; shares $5 each; subscribed $660,250; by A. J. Schohay, 500 shares; Oswald Seifert, 495; H. A. McCarty (minor), 120,050; F. H. Lawn, 495; O. J. Boss, 500; A. E. Bredull, 10,000; J. H. McCarty and F. V. Myers, 5 shares each; place of business, San Francisco.

## TRANSMISSION.

BRIGHAM CITY, UTAH—W, O. Knudson will irrigate his farm west of this place by pumps operated by electricity.

NAPA, CAL.—The Napa Water Company is to put in new electrically operated pumps at its plant northeast of town.

PORNLAND, OR.—The Portland General Electric Company will expend $250,000 on an extension to one of its power plants.

PORTLAND, OR.—W. J. Patterson is preparing to pump water for irrigation purposes near this city. A five horsepower motor will be installed.

RED BLUFF, CAL.—J. H. Leveck has appropriated 15,000 inches of water on the North Fork of Battle Creek and 7000 inches from the South Fork of Battle Creek for the purpose of generating electric power.

WATSONVILLE, CAL.—The Big Creek Power Company has secured a site for an independent plant to be operated on the Watsonville circuit. It is announced that $100,000 will be invested in the new plant.

## TRANSPORTATION.

BERKELEY, CAL.—An ordinance has been passed granting the Oakland Transit Consolidated a franchise to construct and operate additional street railway lines here.

HOLLISTER, CAL.—The Watsonville Transportation Company is considering the advisability of extending its electric road from Watsonville to Hollister, through the San Juan Valley.

BELLINGHAM, WASH.—The city council has granted the Whatcom County Railway and Light Company and the Whatcom-Skagit Interurban Company franchises for additional lines.

EVERETT, WASH.—The county Commissioners have granted to William Snyder, of Snohomish, a franchise to build and operate an electric railway from Snohomish to the King County line.

OAKLAND, CAL.—W. J. Schmidt, of Berkeley, has been awarded the contract for the removal of 25,000 yards of earth along the proposed Amethyst line of the Oakland Transit Consolidated.

## TRADE CATALOGUES RECEIVED.

Crocker-Wheeler Bulletin No. 44, being a reprint of an article on "The Conneaut and Erie Interurban" system, appearing in *The Street Railway Journal* of February 6, 1904.

National Electric Company, Milwaukee, Catalogue No. 61, on direct-current generators and motors in capacities from two horsepower to 1500 kilowatts. Fully illustrated and replete with dimensional and general electrical data.